Technology Review

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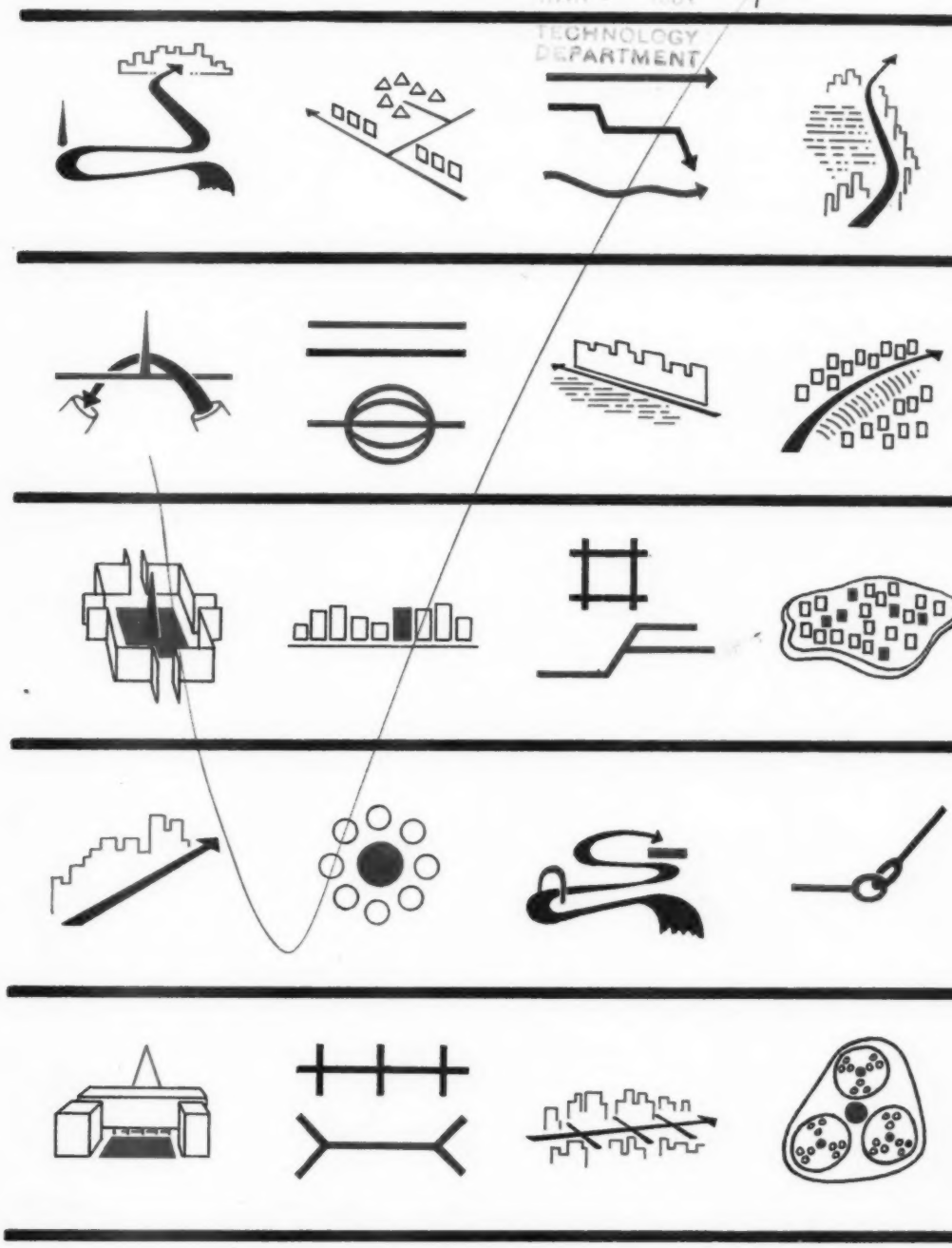

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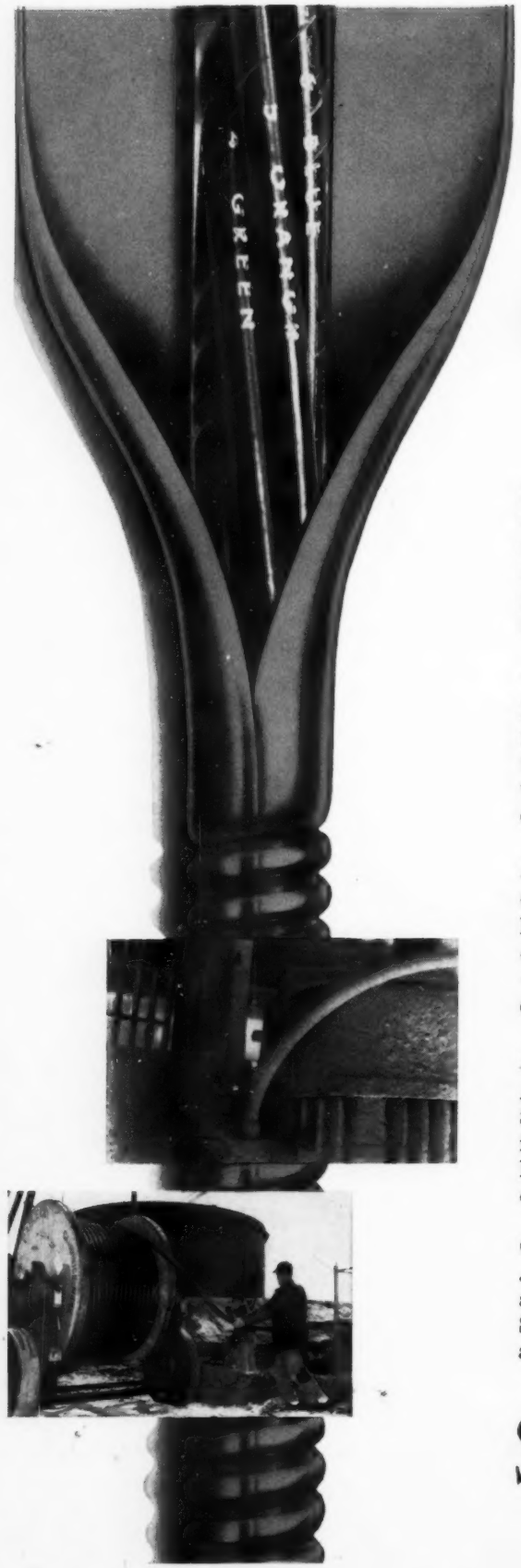

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Technology Review

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Volume 63, Number 3 *Edited at the Massachusetts Institute of Technology* *January, 1961*

Feedback

The Origin of INCAP

FROM ROBERT S. HARRIS, '28:

On page 21 of the November, 1960, number of Technology Review it is stated that I "participated in the meeting of Central Americans which led to the establishment of INCAP (the Institute of Nutrition of Central America and Panama)." M.I.T. played a much greater role in the founding of INCAP than this brief statement implies. I refer you to *Bol. Ofic. San Panamericana*, p. 902-11, 1948.

The concept of INCAP developed during 1943-1944 while I was assisting in setting up the National Institute of Nutrition of Mexico. When Dr. Bianchi, then Minister of Health of Guatemala, invited me to assist in a similar development in his country, I pointed out that Guatemala is relatively small, that the other five countries in the area have similar food and nutrition problems, that it would be more efficient and effective if they could join together and support an international institute, and that this would have more appeal to the foundation which was supporting our work. Dr. Bianchi asked me to prepare plans for this new institute, and the W. K. Kellogg Foundation indicated a definite interest in the idea.

In February, 1946, representatives of the six countries met in Guatemala City under the auspices of the Pan American Sanitary Bureau (PASB). We presented our plan for the organization of INCAP, its financial support by member countries, the training of technical personnel, the office, library and laboratory facilities required, the equipment and chemicals needed, the types of scientific and clinical programs in food and nutrition that would be developed, the potential source of external funds for fellowships and equipment, the selection of a U.S. scientific director, the organization of an executive council to administer the institute, and for a scientific advisory committee.

(Concluded on page 10)

DONALD H. SHAW, '60, *pictured here with Mrs. Shaw, is now attached to the Ministry of Finance in Dar es Salaam, Tanganyika, Africa. This and other posts in which M.I.T. men now are serving were found for them by Carroll L. Wilson, '32, who discusses Africa's problems as though they were those of a business firm in the article on page 29. Other recent graduates now in Africa are pictured on page 28.*

EDITOR: Volta Torrey; BUSINESS MANAGER: R. T. Jope, '28; CIRCULATION MANAGER: D. P. Severance, '38; EDITORIAL ASSOCIATES: J. J. Rowlands, Francis E. Wylie, John I. Mattill; EDITORIAL STAFF: Ruth King, Muriel R. Roberts, Norma G. Humphries; BUSINESS STAFF: Madeline R. McCormick, Marianne G. Hagerty; PUBLISHER: H. E. Lobdell, '17.

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Individuals Noteworthy

New Posts

NAMED in the news recently were the Alumni whose elections, promotions, and appointments are reported below:

Bernard L. Landers, '15, as a Trustee, Beth Israel Hospital, Boston, Mass. . . . *Raymond H. Blanchard, '17,* re-elected President, Associated Industries of Massachusetts . . . *John R. Coffin, '17,* as President, Jackson & Moreland, Inc.;

John J. Healy, Jr., '21, as President, American Institute of Chemical Engineers . . . *Clinton B. F. Brill, '22,* and *Kenneth A. Roe, '41,* respectively, as President, and as Vice-president, Brill Engineering Corporation, New York City;

Donald G. Vaughan, '25, as Assistant Vice-president, Aetna Casualty and Surety Company and Standard Fire Insurance Company, Hartford, Conn. . . . *Joseph F. Clary, '29,* as Vice-president, Sales, Railway Division, The Budd Company, Chicago, Ill.;

Frederick E. Mader, '32, as Assistant Divisional Manager, New England Fire Insurance Rating Association, Worcester, Mass. . . . *Samuel A. Groves, '34,* as a Director, First National Bank of Boston . . . *John R. Newell, '34,* as President, Society of Naval Architects and Marine Engineers;

Harold E. Thayer, '34, as President, Mallinckrodt Chemical Works, St. Louis, Mo. . . . *Benjamin F. Schlimme, Jr., '35,* and *Charles J. Harrington, '38,* respectively, as Planning Manager, Industrial and Biochemicals Department, and as Assistant General Manager, Elastomer Chemicals Department, E. I. du Pont de Nemours & Company;

Robert V. D. Campbell, '38, and *Charles L. Register, '50,* respectively, as Director, Research, and as General Manager of the Laboratories, Burroughs Corporation . . . *Robert B. Gordon, '39,* as Manager, Technical Operations, Atomics International Division, North American Aviation, Inc., Canoga Park, Calif.;

George J. Laurent, '39, as Executive Vice-president, General Atronics Corporation, Bala-Cynwyd, Pa. . . . *John W. Lovely, '39,* as Service Manager, Bryant Chucking Grinder Company, Springfield, Vt. . . . *Paul N. Stanton, '39,* as Vice-president, Marketing, Pratt & Whitney Company;

Stanley E. Webber, '41, and *William W. Smith, '49,* respectively, as Manager, Engineering, Traveling-Wave Tube Product Section, Palo Alto, Calif., and as Manager, Marketing, Plainville, Conn., General Electric Company . . . *Paul L. Hotte, '42,* as President, Mallory Metallurgical Division. P. R. Mallory and Company, New Bedford, Mass.;

Robert W. Beatty, '43, as Chief, Microwave Circuit Standards Section, National Bureau of Standards, Boulder, Colo. . . . *Charles A. Hathaway, '43,* as Vice-president, Torrington Manufacturing Company, Torrington, Conn. . . . *William S. Edgerly, '49,* as Treasurer, Godfrey L. Cabot, Inc., Boston, Mass.;

James A. Daley, '50, as Associate Director, Electronics Research, Prudential Insurance Company, Boston, Mass. . . . *Harry E. Gravlin, Jr., '50,* as Operations Manager, Hamilton Standard Division, United Aircraft Corporation;

Irvine F. Williamson, '50, as Plant Superintendent, Norton Company, Santa Clara, Calif. . . . *Forest C. Monkman, Jr., '51,* as Vice-president, Engineering and Research, Walworth Company, Boston, Mass.

Weisskopf to CERN

AN M.I.T. Professor of Physics, Victor F. Weisskopf, has been appointed a scientific director of the European Organization for Nuclear Research (CERN) even though the United States is not one of its 13 members. Professor Weisskopf was born in Vienna and educated at the University of Göttingen. He came to the United States in 1937 and has been an American citizen since 1943, when he joined the Manhattan Project.

(Continued on page 8)

STUDIES OF FRICTION WELDING in American Machine & Foundry Company's Central Research Laboratory at Stamford, Conn., are reported to have resulted in a better understanding of the process. Pictured here during the welding of high carbon steel are M. B. Hollander, '53 (left), and F. Camps-Campins.

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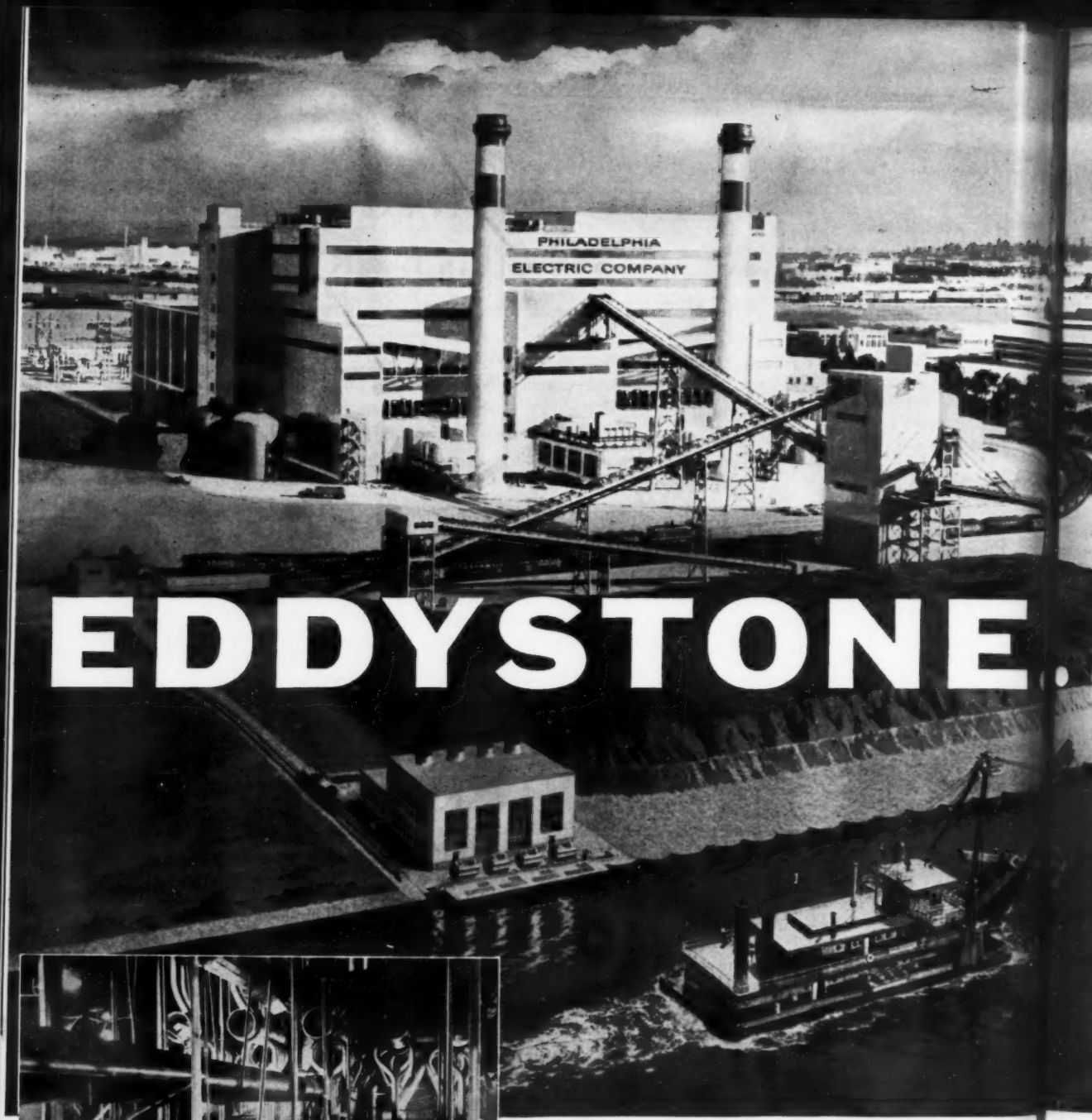

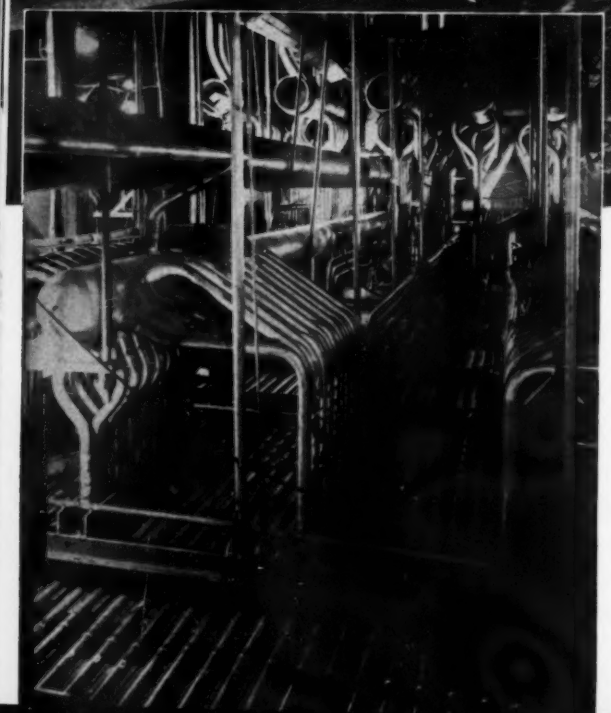

(Above) The Eddystone station of Philadelphia Electric Company. It contains two 325,000-kilowatt turbine-generators, both utilizing "supercritical" pressure steam supplied by Combustion Engineering boilers of the C-E Sulzer Monotube design.

(Left) Perched atop the furnace roof at Eddystone, this complex maze of headers and tubes is part of the arterial system through which water and steam flow. Each furnace (there are two per boiler) stands as high as a 14-story building. The boiler contains approximately 170 miles of tubing and, when running at full capacity, consumes about 100 tons of coal an hour.

JA

At the Eddystone station of Philadelphia Electric Company, steam, harnessed and squeezed to the record "supercritical" pressure of 5,000 pounds per square inch, is used to spin a giant 325,000-kilowatt turbine-generator—a machine capable of supplying the residential electric needs of a city of about two and one half million people. The steam is supplied by a single Combustion Engineering boiler—a C-E Sulzer Monotube Steam Generator—which, in addition to being the world's highest pressure boiler, is designed to produce steam at a record-breaking 1200°F—a temperature high enough to melt lead, zinc or magnesium. The temperature of this steam so greatly exceeds the capabilities of normal metals that specially compounded stainless steels were developed to contain it. Even they glow a cherry red. This unit was placed in commercial service in February, 1960.

The world's most advanced power station

A second 325,000-kilowatt unit, also operating in the "supercritical" pressure range, was placed in service at Eddystone in October, 1960. It, too, is served by a C-E Sulzer Monotube Steam Generator.

The pressure-temperature conditions of Eddystone No. 1 are equaled nowhere in the world and represent the world's most efficient power plant cycle. The adoption of these new highs by Philadelphia Electric Company exemplifies the continuing efforts being made by the utility industry to assure that electric energy remains the country's best buy.

Thus, as the decade of the sixties begins its second year, power plant progress continues apace. It is gratifying to note that, as in the decade past, boilers designed and built by Combustion continue to account for about 40 per cent of the new capacity being added by America's electric utility industry.

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Individuals Noteworthy

(Continued from page 4)

Centennial Participants

WORLD LEADERS in the arts, science, engineering, and technology who will be in Cambridge during the observance of M.I.T.'s centennial this spring will include:

Raymond Aron, Professor of Political Science, Sorbonne, Paris.

Sir Eric Ashby, Master of Clare College, Cambridge, England.

Lloyd V. Berkner, Brookhaven National Laboratory Director, New York.

H.B.G. Casimir, Director of Research, Philips, Eindhoven, Netherlands.

Brock Chisholm, World Health Organization, Canada.

Lucio Costa, planner of Brasilia, Brazil.

Sir Willis Jackson, Director of the Association of Electric Industries, Manchester, England.

Humayun Kabir, Minister of Education and Cultural Affairs, India.

D. S. Kothari, Professor of Physics, Delhi University, India.

W. Arthur Lewis, Principal, University College of West Indies, Jamaica, B.W.I.

Robert S. Morison, The Rockefeller Foundation, New York.

Eni Njoku, Professor of Botany, University College, Ibadan, Nigeria.

Pier Luigi Nervi, architectural engineer, Italy.

Sven Markelius, architect and city planner, Sweden.

I. I. Rabi, Professor of Physics, Columbia University, New York.

Adam Schaff, Professor of Linguistics, University of Warsaw.

To Give Recitals

THE M.I.T. Humanities Department will present Marie-Claire Alain and Lady Susi Jeans in organ recitals in Kresge Auditorium at 8:30 P.M. on March 1 and April 12 respectively.

Lady Susi Jeans is the widow of the British scientist, Sir James Jeans. She is noted both for her performances as an organist and harpsichordist and her work in the field of music history.

Marie-Claire Alain, a recipient of the Grand Prix du Disque, will be making her first visit to this country.

(Concluded on page 46)

Said Gaspard de Coriolis: *"A particle which is subject to no forces in a rotating coordinate system experiences a radial acceleration and a tangential acceleration."*

It was around 1840 that Coriolis discovered what has since become known as the Coriolis Effect. He noticed objects above the earth tend to rotate relative to the earth's rotation . . . to the right in the northern hemisphere, to the left in the southern.

The Coriolis Effect is in force in outer space, too. If a space vehicle is rotated in order to establish artificial gravity, the necessarily short radius of the rotation causes a Coriolis force. This creates orientation problems for a human occupant. To eliminate this difficulty, a scientist at Lockheed Missiles and Space Division conceived the idea of connecting the vehicle to an auxiliary fuel tank by a half-mile-long cable. Thus, if the whole system is then rotated at a reduced speed around its center of mass gravity, the longer radius greatly minimizes the Coriolis force. Right now—on the drawing boards at Lockheed—is an enormously advanced space vehicle system which utilizes this concept, in addition to many others.

Fortunately, natural laws are about the only restrictions which circumscribe scientists and engineers at Lockheed Missiles and Space Division. The climate in Sunnyvale and Palo Alto, on the San Francisco Peninsula, is close to perfection. The creative atmosphere—the opportunity to work on such important projects as the DISCOVERER, MIDAS and SAMOS satellites, the POLARIS FBM, or even more advanced concepts such as the space system cited above—is the dream of the creative engineer.

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Feedback

(Concluded from page 3)

This plan met with enthusiastic approval by all delegates, Guatemala offered to put up the building, and PASB was asked to be responsible for the organization of INCAP. During 1948-1949 three chemists, three agronomists, one nutritionist, and three physicians attended M.I.T. under fellowships provided by the W. K. Kellogg Foundation. We drew up the plans for the new INCAP building and selected equipment and chemicals for the laboratories, and these were ready in the fall of 1949.

The PASB was indeed fortunate in selecting Dr. Nevin Scrimshaw as the first scientific director of INCAP. The brilliant direction he has given INCAP during its first 12 years is the chief reason for its world-wide reputation. Only those who have worked in scientifically underdeveloped areas can fully realize the full importance of this achievement. For five years I served as a member of the advisory committee and watched this experiment in international scientific collaboration bud and then blossom.

It is fitting therefore that M.I.T. should continue to participate and counsel in the programs of INCAP, for in a very true sense they are related as father and child.

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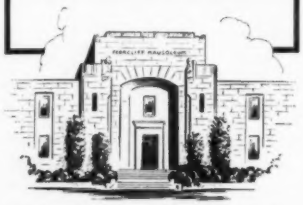

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Donald W. Douglas, Jr., President of Douglas, discusses valve and fuel flow requirements for space vehicles with Dr. Henry Ponsford, Chief, Structures Section.

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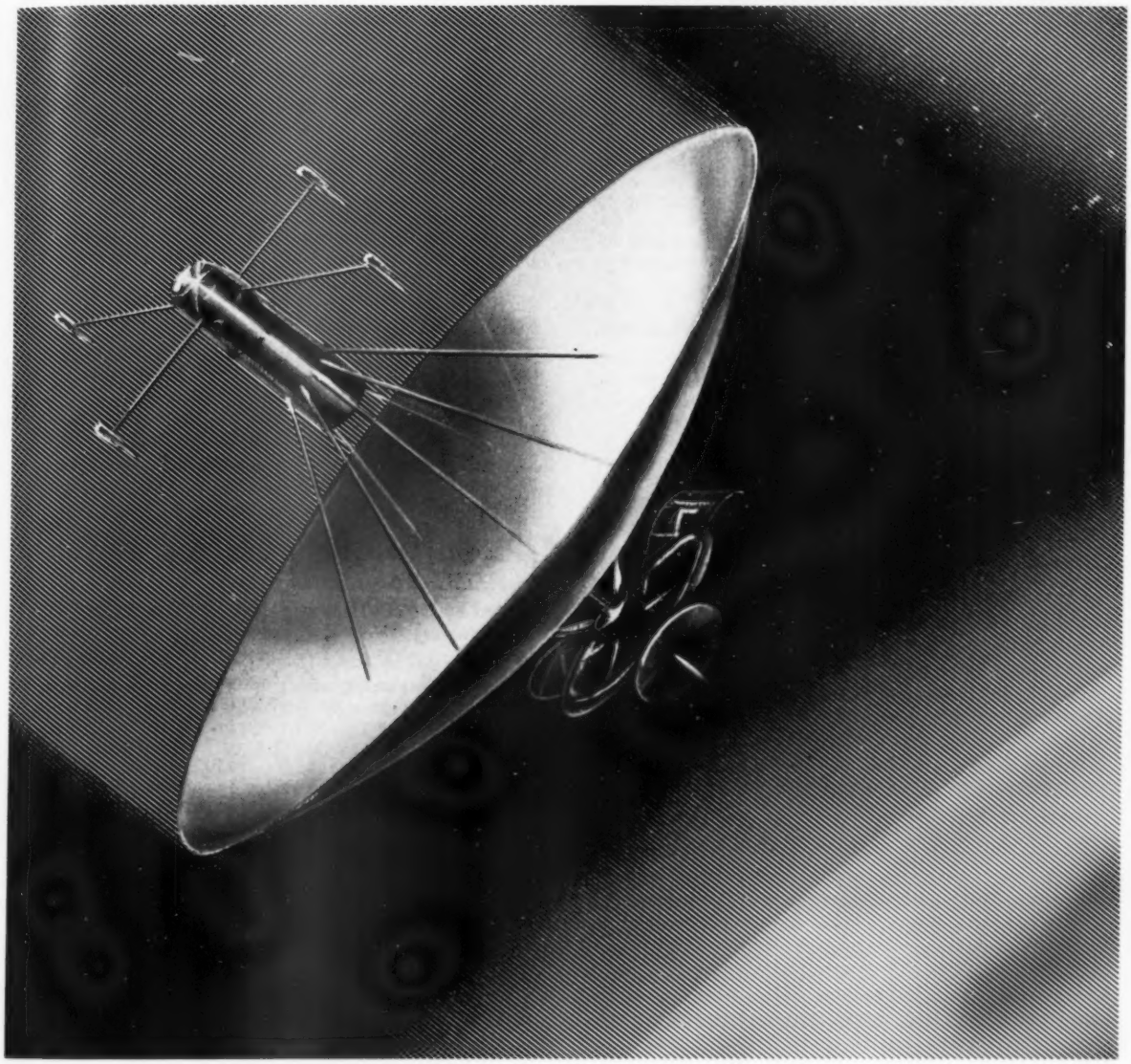

Advanced power conversion systems for space vehicles utilizing energy of the sun or heat from a nuclear reactor are now being developed by Garrett's AiResearch divisions. Under evaluation are dynamic and static systems which convert heat into a continuous electrical power supply for space flight missions of extended duration. Component and material developments for these systems are being advanced in the fields of liquid metals, heat transfer, nonmechanical and turboelectric energy conversion, turbomachinery, alternators, and controls — vital contributions by Garrett to the conquest of space.

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ELECTRONICS IN ENGINEERING. *Second Edition*

By W. Ryland Hill, University of Washington. 352 pages, $8.00.

This revised and updated second edition is designed for non-E. E. majors and intended as a sequential extension of the Loew-Bergseth text. The elements of vacuum and solid state electronic devices, examples of their use in electronic circuits and an analysis of these circuits are included. The text presumes a knowledge of basic circuit theory.

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A revision by two top men in their field of a 1923 classic. The informal and much-admired style of the first edition has been retained and will make the book very appealing to all its readers. Because the last edition of the book was 37 years ago, there is much new material included in the new edition, particularly in the middle and late chapters. These chapters have now been brought up to the present frontiers of thermodynamics. Illustrative materials have been brought up to date. As before, illustrative problems are worked out in considerable detail.

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A sophomore level text covering the principles involved in all important manufacturing materials and processes: heat treatment, casting processes, hot and cold working processes, machinery processes. Emphasis is placed on general principles rather than particular machines. Line drawings and chapter bibliographies.

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A text for engineers, scientists, mathematicians, students, teachers and others who wish to become or remain informed concerning current applicable mathematical developments. Topics included have had recent spectacular applications in mathematics or are likely soon to be applied in physical, sociological or biological sciences—in either case they involve a degree of mathematical subtlety.

PRINCIPLES OF INERTIAL NAVIGATION

By C. J. Savant, University of Southern California; Robert C. Howard, Giannini Controls Corporation; and C. A. Savant, Northrop Corporation. Ready this month.

A senior-graduate text devoted entirely to inertial navigation. This book will be of great interest to people concerned with missile engineering and space technology. Previously classified information is presented with a systematic summation of the unclassified literature in the field. General bibliography included.

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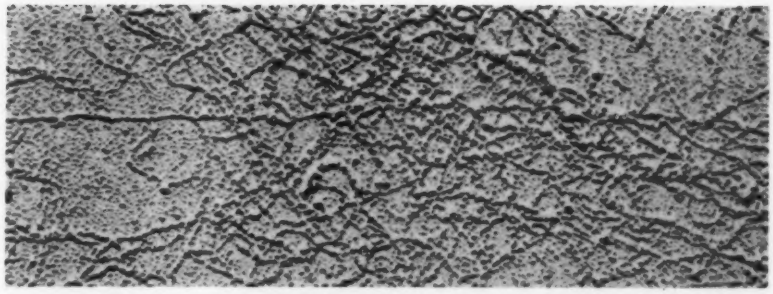


For International Service

THE INSTITUTE of International Education has presented an award for international service to M.I.T. Such a citation is given every two years "to dramatize the magnitude of the creative contribution which the colleges and universities of the United States can make to the mutual development of nations."

James R. Killian, Jr., '26, Chairman of the Corporation, accepted this award in M.I.T.'s behalf in San Francisco last month.

"M.I.T., which is celebrating its centennial, is known and respected in every corner of the globe," the citation stated. "Technical 'know-how' is characteristic of American life, but the scholars of M.I.T. have built a university in which scientific study and research to improve the condition of man have reached new heights.

"Technical development is not M.I.T.'s only contribution. Strong programs in the humanities and the social sciences give M.I.T.'s engineers, scientists, architects and administrators the breadth of vision vital to the use of their skills. In this technological institution a distinguished Center for International Studies provides incisive answers to the complex problems of modern social and industrial life.

"M.I.T. not only welcomes scholars from abroad—it encourages its own staff and students to help other nations in planning their new industrialization."

Make-Believe Worlds and Brains

FURTHER DEVELOPMENT in the theory of computers, Professor Claude E. Shannon, '40, suggested at a Hayden Colloquium this fall, may make new approaches possible to problems of epistemology and causality. Professor Shannon's topic was "Causality in Real and Simulated Worlds," and he discussed the history of the causality concept in physical science together with various possible types of causality in mathematical models of universes.

As science has advanced, he pointed out, some experiments that were suggested in the past no longer seem possible to carry out, although the number of technologically feasible experiments has increased. We know now, for example, that an experiment requiring a speed greater than that of light cannot be performed, but improvements in our instruments, machines, and insights have made other experiments that formerly seemed impossible now appear to be technically feasible.

As currently viewed, the human brain has a finite number of inputs from its environment and a finite number of ways of affecting that environment. Though not yet practical, it is conceivable that an artificial brain could be built and placed in an artificial environment. Both this brain and its environment would be super-duper computers, which would feed and be affected by each other. The brain-like computer would have no way of knowing that the environment supplied by the other computer was not real. The artificial environment could be made even more capricious, if one wished, than the real world, and be made to simulate a great range of conceivable environments.

A study of a simulated brain's behavior in various simulated environments, Professor Shannon concluded, would enable us to embed philosophical questions concerning epistemology, causality, and the like in mathematical models. Thus sharper meanings and, in some cases, definite answers are possible for these questions.

Filaments Within Nerves

FOR A SYMPOSIUM on "Unsolved Problems in Biology" during the recent New York meeting of the American Association for the Advancement of Science, Peter F. Davison of M.I.T. reviewed some of the biologists' knowledge of molecular organization within neurons.

These nerve cells which transmit impulses from sensory organs to the brain have long extensions called axons. Much research has been devoted to the membrane phenomena associated with the impulse transmission along the axons, but recently evidence of chemical changes occurring within the nerve cell after stimulation has directed attention to structures within the neuron and its axon. One such structure, a fibrous protein, has been studied in the Institute's Department of Biology. Obtained from huge squid caught off the coast of Chile, this protein is flown to M.I.T.

When shadowed by metal and magnified 25,000 or more times, the filaments shown in the photograph at the top of this page can be seen and studied. Whether these filaments figure directly or indirectly in the excitation of the nerves or whether they participate in metabolic processes is not known. Such fibers, however, are found in all nerve cells and axons and hence they probably have an essential role to play in neuronal function.

The High Building For Earth Sciences

GROUND was broken last month for the building that will house the Center for Earth Sciences at M.I.T. It was made possible by a gift from Cecil H. Green, '23, and Mrs. Green, of Dallas, and is scheduled to be completed in 1962. This will be the first 20-story building in Cambridge. It will be east of the Compton and Dorrance Laboratories, about 200 yards north of Memorial Drive. It was designed by I. M. Pei, '40, and his associates, and is pictured elsewhere in this issue with other examples of their work. (See Page 22.)

This high structure, 120 feet long and 50 feet wide, will be unusual in several respects:

¶ Four corner columns will support it. Stair, elevator, and mechanical shafts will be in the building's ends, leaving all floors free of structural obstructions.

¶ Its floors will be prestressed concrete joists, resting on floor-high Vierendeel trusses, the webs of which will be hollowed out by oval windows. These trusses will transmit their loads to the four corner supports, and the whole will be braced against the wind by the end walls. The ground floor will be completely open except for the entrance lobbies.

¶ The exterior of the building will be cast architectural concrete and the surface will be lightly sandblasted to expose some of the stone aggregate. Aside from its 325-foot height, its most eye-catching feature will be its oval windows.

The Center for Earth Sciences which this building will accommodate is one of five new major centers for research and graduate study included in the Second Century Program. Its facilities are now mainly in Buildings 20 and 24. The former is the temporary wooden structure which housed the wartime Radiation Laboratory, and the latter is a seven-story building that is now overcrowded.

The **first floor** above ground level in the new building will be occupied by an auditorium seating 250 persons and intended for general use. On the **second floor,** the final one accessible by a main stairway, visitors will find three large classrooms, three seminar rooms, and a student lounge. Proceeding upward to the other floors one will see:

Third—Teaching laboratories for the Department of Geology and Geophysics and a storage area for rock samples and ores.

Fourth—Research and teaching laboratories in paleontology and structural and historical geology.

Fifth—A laboratory for high-pressure experimentation and study of phase changes in minerals, the Geology Department's machine shop, and faculty offices.

Sixth—Four more faculty offices, and facilities for research and teaching of geophysics.

Seventh—The crystallography laboratory directed by Institute Professor Martin J. Buerger, '24; the headquarters of the School for Advanced Study which he heads; and additional research facilities, a classroom, and a seminar room.

Eighth—The Cabot Spectrographic Laboratory; laboratories for sedimentology and related subjects; three more faculty offices and one seminar room.

Ninth—The mass spectroscopy room, a room for the separation of minerals, a chemistry laboratory, and quarters for professors and graduate students.

Tenth—Headquarters of the Department of Geology and Geophysics, a faculty lounge, a large classroom, and a good-sized seminar room.

Eleventh—The Lindgren Library.

Twelfth—A teaching laboratory for sedimentology, stratigraphy and petroleum geology, another classroom and seminar room, and offices for teachers.

Thirteenth—Offices, graduate student rooms and facilities for the study of geochemistry, including radiochemistry.

Fourteenth—Facilities for research in chemical oceanography and meteorology.

Fifteenth—Laboratories, faculty offices, and graduate student rooms for researchers in meteorology.

Sixteenth—Headquarters of the Department of Meteorology, offices, seminar rooms, and laboratories.

Seventeenth—The synoptic meteorology room, plotting room, two laboratories, offices, and a seminar room.

Eighteenth—A meteorological instrument laboratory, and more offices and rooms for classes.

Nineteenth—Weather radar console room and staff laboratories, plus a machine shop.

Twentieth—This, in addition to air-conditioning gear and other mechanical requirements, will contain a radar transmitter, and the roof will be a complete meteorological laboratory.

From this high point, the meteorologists will have an unrestricted horizon for their radars, balloon-sounding equipment, and other atmospheric probes. They will be above much of the smoke and dust of the city and have one of the finest views obtainable of Cambridge and Boston.

Three weather radars, each at a different level on the roof, will be able to "see" many miles without interference from surrounding buildings, watch the approach of rainstorms, and help keep M.I.T. in the forefront of the "new, vital and exciting era" which Professor Henry G. Houghton, '27, forecasts.

All told, about 150 carefully selected graduate students and 50 undergraduates will work in the new building under the guidance of 50 professors. Distinguished foreign earth scientists will join them from time to time. "Eager students," Professor Robert R. Shrock promises, "will have the opportunity to participate in great advances—and they will learn by doing, the dominant attitude in all M.I.T. activities."

The new center, President Julius A. Stratton, '23, predicted as ground was broken for it, "should stimulate a much closer integration of our efforts in both teaching and research and give our whole program in the earth sciences a drive it could not otherwise achieve."

"In thinking of the new center," said Mr. Green, "I am obsessed with the idea that it is to serve as a forum, or a meeting place, for those mathematicians, physicists, chemists, biologists, and engineers who happen to have an interest in the problems of the earth sciences. . . . With this integration of interests, we are bound to have a center here that will attain great international as well as national stature."

A European M.I.T. Is Urged

A STUDY of ways whereby science in the Western world might be strengthened has resulted in a recommendation that the nations of western Europe consider the establishment of an International Institute comparable to M.I.T. "in size, scope, and quality."

This study was suggested at meetings of the Science Committee of the North Atlantic Treaty Organization, and was made by a distinguished committee headed by M. Louis Armand, former President of French Railways and former President of EURATOM. The Ford Foundation provided financial help, and the Fondation Universitaire of Brussels administered the funds.

As envisioned by the committee, the proposed International Institute would be a center for research in oceanography, meteorology, materials, space, and other areas of science. It would concentrate on work at graduate level, grant its own degrees, and welcome students from less developed countries.

"Although it is doubtful," the committee wrote, "whether any single European country has the resources in man power and money to proceed on its own, it is certain that western Europe as a whole could easily muster the required talent and equipment."

The "Russian" Dormitory

TEN M.I.T. STUDENTS living on the third floor of Senior House now speak only Russian there. Guided by David Pearlmutter, instructor in the Department of Modern Languages, they do this voluntarily—and recently led some visitors from Russia to think that the Institute had "a Russian dormitory." They have fooled others, too, by conversing in Russian during meals.

In these students' rooms, everyone speaks in Russian.

Station Manager "Buck" Rogers, Jr., '61, at a WTBS mike.

WTBS-FM Due in April

THE M.I.T. STUDENTS' radio station, WTBS, is preparing to become WTBS-FM, 88.1 megacycles, and thus to enlarge its audience to include all living groups, nearby colleges, and other listeners within a few miles of the Institute. Permission to construct and test equipment required for the step has been received from the Federal Communications Commission. The first FM broadcast, it is now hoped, will be made during Centennial Week.

Human Potentialities

IN THE LAST of six lectures entitled "What a Piece of Work Is a Man," at M.I.T. last fall, Aldous Huxley pleaded for a systematic study of means of realizing more of man's potentialities. Physiologically, he observed, we have not changed much in the last 20,000 years, but our achievements and opportunities have become greater. It is likely, he continued, that potentialities for rationality, affection, and creativity still lie latent in us, and might be brought out in a variety of ways. But, he concluded, since "truth lies at the bottom of the well, and the well is very often muddy," much more study is needed of means of developing human potentialities.

All of Mr. Huxley's lectures in Kresge Auditorium drew capacity crowds. They were presented by the Department of Humanities, as part of the Institute's Centennial Program, and Mr. Huxley will return to Cambridge to participate in the exercises in April.

An Institute Historian

JOHN S. MASLANKA, '61, of New Bedford, Mass., helped prepare the Boston *Herald's* 180-page Sunday supplement last fall about M.I.T., and now has chosen as the subject for his senior thesis: "William Barton Rogers' Conception of an Institute of Technology."

President Rogers, he says, raised engineering from a craft learned by serving an apprenticeship to a profession taught by the scientific method, and also started the "tough educational policy" at M.I.T. with his grade system: *G* for good, *S* for satisfactory, *P* for poor, and *N* for "next to nothing."

Mr. Maslanka's digging is helping many of those responsible for centennial affairs.

The Waste-Makers' Problems

AT THE National Conference on Water Pollution last month in Washington, Professor Rolf Eliassen, '32, of M.I.T.'s Department of Civil and Sanitary Engineering pleaded for more study of the effects of new and exotic chemical contaminants, techniques of recovering waste materials, and means of preventing various kinds of stream pollution.

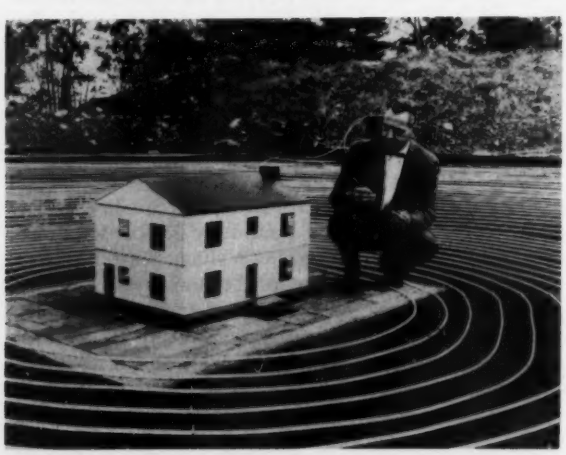
Some of the new synthetic chemicals pass unchanged through water-treatment plants and are not oxidized by the natural self-purification processes of streams, he warned. "To leave no stones unturned," he said, "this conference must ask the chemical industry: What are the chances of changing the structure of some of the widely used synthetic chemicals which contribute to water contamination? It should not be difficult for the chemical industry to develop a different series of compounds and produce some which could be broken down by bacteria, and still be relatively inexpensive."

His recommendations also included a call for research regarding the incidence of viruses in municipal waste waters. "Water filtration plants," he pointed out, "are not capable of removing viruses. Very little is known about the viral contamination of ground waters or streams, or of the fate of viruses in the water environment. Much research is needed in this field, perhaps taking advantage of modern radioactive tracer techniques to tag viruses and follow their behavior."

Such work is now being undertaken in the Sedgwick Laboratories of Sanitary Science at M.I.T.

Fall-Out Simulation

A NEW MEANS of assigning "shelter factors" to buildings of all kinds for civil defense was revealed this fall by Eric T. Clarke, '44. By pumping a pellet of radioactive cobalt through a hose laid out in concentric circles around a model of a building, he can simulate the effects of fall-out from nuclear explosions and determine how much less persons in various parts of the building would be affected than they would be if they remained outdoors. Dr. Clarke is vice-president for Research and Development of Technical Operations, Inc., which devised this method of evaluating shelters for the Office of Civil and Defense Mobilization.



Eric T. Clarke, '44, with a pellet used to study fall-out.

Apparatus Aloft

THREE BIG BALLOONS carried apparatus to altitudes of more than 100,000 feet last year for the Cosmic Ray Group of the M.I.T. Laboratory for Nuclear Science. The third flight was made in October, from near Bruning, Neb., to Port Clinton, Ohio, and took about 15 hours. Medford Webster, a guest of the laboratory, now is analyzing the data recorded on photographic film during this flight, as part of the cosmic gamma-ray research which the Atomic Energy Commission, the Navy, and the Air Force sponsor jointly.

"The experiment," Dr. Webster told reporters when the 3,800,000-cubic-foot sphere rose with a 1,000-pound gondola full of apparatus beneath it, "will help us learn more about how the sun works. From such space explorations, we can better determine what reaches the earth from outer space."

Progress With Magnetism

A NEW metallic compound with unusual magnetic characteristics—described at a Conference on Magnetism in New York in November—has resulted from research done by Monroe S. Sadler, '42, and Howard S. Jarrett, '51, with others in the Central Research Department of E. I. du Pont de Nemours and Company.

It is a brittle, gray manganese compound that becomes magnetic when the temperature rises above a certain point and ceases to be so when the temperature drops below that point. This transition point is predetermined by the material's chemical composition, and can be adjusted over a range of several hundred degrees by changing the composition of the compound. It is leading, the Du Pont Company reports, "to a better basic understanding of magnetism."

The Oceanographers Return

THE LARGEST of the Woods Hole Oceanographic Institution's five ships, the *Chain,* completed a five-month cruise in November that took three dozen scientists and 10 students north of the Arctic circle and into five European ports. Over the mid-Atlantic ridge, bottom samples and photos were obtained, and the heat flow from the earth's interior was measured. For nearly 20,000 miles, the *Chain* towed astern a 600-foot instrument-carrying line with which continuous temperature recordings were made. Much of the work, involving both old and new techniques, was done in the North Sea, the Norwegian Sea, and the North Atlantic between Iceland and the British Isles. The American scientists co-operated in these studies with those aboard Norwegian, British, and Scottish research vessels.

The Alumni Council's Meeting

AT ITS November meeting, the M.I.T. Alumni Council heard B. Alden Thresher, '20, discuss efforts of college admissions officers to promote the best possible use of human resources, and Francis Bitter, Professor of Geophysics, describe the powerful, new magnets to be constructed under his direction. James F. Hoey, Jr., '43, read a tribute to the late Robert W. Anderson, '43; and F. Leroy Foster, '25, reported that 6,278 individuals had contributed $196,400 to the Alumni Fund to date. Clarence L. A. Wynd, '27, President of the Association, presided.

How We See Our Cities

A study of mental images of Boston, Los Angeles, and Jersey City suggests that our cities could be "a pleasure to live in and look at"

By KEVIN LYNCH

In Los Angeles on Seventh Street an old, two-story gray wooden building is anthropomorphized as "the little gray lady."

IT IS COMMON opinion that the city is an ugly, uncomfortable place, something to be endured in resignation. Opinion goes on to say that, since it is hopeless to try to beautify anything as big, confused, and expensive as a city, it is uncommonly lucky that most people don't pay much attention to what they see around them anyway.

It is difficult to deny that our cities are ugly and confused, but common sense is probably mistaken on the other two counts: most people *are* attentive to what they see in the streets and are much affected by it. Moreover, it is possible to give harmonious form even to something as large as a metropolitan region, although it will require resources, skill, and determination that we have until now failed to apply.

We are making comprehensive plans for city and metropolitan areas with important objectives of improving health, safety, economy, social cohesion, or traffic flow. Rarely are those plans directed to improve the look of our cities, or indeed to deal with any of those features which add pleasure to city life, the elements which have always distinguished the great cities of the world from their more humdrum neighbors. The American city planner was badly hurt in the collapse of the "City Beautiful" movement over a generation ago, and not until recently has he dared to go beyond "practical realities."

The psychological and aesthetic impact of a city is just as important, for human beings, as its effect on traffic, on productive efficiency, or physical health. The subjective response to city arrangement should be an important consideration in the preparation of city

KEVIN A. LYNCH, '47, *Associate Professor of City Planning at M.I.T., was co-director with Gyorgy Kepes of a study of the perceptual form of the city, and is the author of* THE IMAGE OF THE CITY *(The Technology Press and Harvard University Press, $5.50). He is a former student of Frank Lloyd Wright and has had wide practical experience on urban projects.*

plans. To this end, we have been engaged in some studies of the direct effect of the city on the citizen through his senses. A part of this work is reported in a recent book (*The Image of the City*) which deals with the mental picture that people have of the physical city they live in, and how that picture is put together.

Urban America has been delineated, often in acid lines, by many artists. Its features are also reflected in the words of a woman from Jersey City whom we interviewed: "This is really one of the most pitiful things about Jersey City. There isn't anything that if someone came here from a far place, that I could say, 'Oh, I want you to see this, this is so beautiful.' " Or in the comment of a more recent arrival to Los Angeles: "It's as if you were going somewhere for a long time, and when you got there you discovered there was nothing there, after all."

We were interested to see what kind of an image of their home city people carried in their heads, and how, if at all, it was affected by the actual physical shape of the city itself. For people perceive a large-scale environment only through a remembered mental image, and the quality of that mental image is the ultimate source of their pleasure in their surroundings, or of their disgust. Whether that picture is clear or confused, meaningful or blank, intimate or alien, stimulating or dull, is what determines whether one's city is great or mean.

Beyond conducting another opinion poll, we were interested to learn how physical changes affected the mental image, and to verify and develop our own intuitions about the design of cities. In particular, we believed that one important ingredient of a handsome city was that it be "legible," or "imageable," i.e., that it be easy for a resident to put together a clear and vivid mental picture of his town. If this were true, we wanted to learn how the trick was done. We suspected that such clarity would do more than simply help one to find one's way easily: that it would prove to be a fundamental source of security and pleasure.

A number of tests were made of the central areas of three American cities: Boston, Los Angeles, and Jersey City. A careful analysis was made in the field, picking out the visual strongpoints, and how they linked together or failed to do so. Old residents were interviewed at length about their picture of the city: they were asked to characterize it, draw maps of it, or tell us how to get from one place to another. People were stopped on the street for quick descriptions and directions, others were taken for long walks, or asked to identify photographs.

When we compared these various views of the city, we found remarkable similarities—there seemed indeed to be a sort of "public image" of a city. And we concluded that we were able to predict most of the public image from our original analysis of the look of that city. We found that people used rather standard ways of putting their mental picture together, imagining their city to be a mosaic of distinct districts, or a network of pathways, or a constellation of focal points and landmarks. We were able to say something about how a planner should lay out a city if he wants the residents to hold a clear mental image of it.

Scollay Square in Boston: people cannot recall its shape.

Boston's Louisburg Square is vividly remembered.

This Boston corner is the center of the city's center.

A street in Jersey City. "You can't decide which avenue you want to go on, because they're more or less just the same."

Pershing Square is a strong element in Los Angeles.

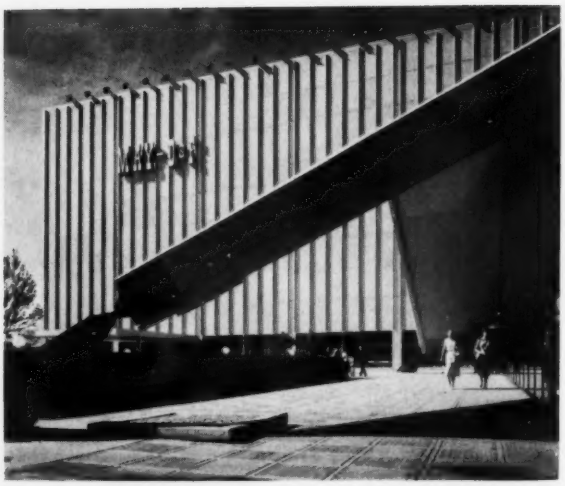
Bunker Hill is isolated in the image of Los Angeles.

We found, for example, that nearly all the Bostonians we interviewed knew and loved the Common, and made it a central pivot of their mental map. With almost equal unanimity, they could not sketch its boundaries correctly, or imagine clearly how to go from one side to the other. This failure produced a surprising amount of concern, even in memory. As a contrast to the Common, most of them could not recollect the area between Haymarket and the North Station, except as a vague impression of chaos and weariness.

For each city, we could in the end draw a rather detailed map which illustrated, not the "real" physical city, but the distorted reflection of it, suffused with meaning and emotion, that appeared in men's minds. Each city had its own interesting peculiarities, but there were enough similarities in the relations between image and reality to make us think that we had some clues for the design of cities: ways to make a street system easy to move through mentally, ways to make a focal point vivid, or a district distinct and memorable.

These clues may in fact prove mistaken or superficial. Our more stubborn conclusion is that we must begin to put our minds and our resources to building cities that are a pleasure to live in and to look at, cities that can be remembered and imagined with clarity and affection. We remain convinced, not only that our cities are ugly, but that we pay a price for that ugliness. We believe that we are learning ways by which the alien and confusing landscape in which we live can be brought closer to heart's desire.

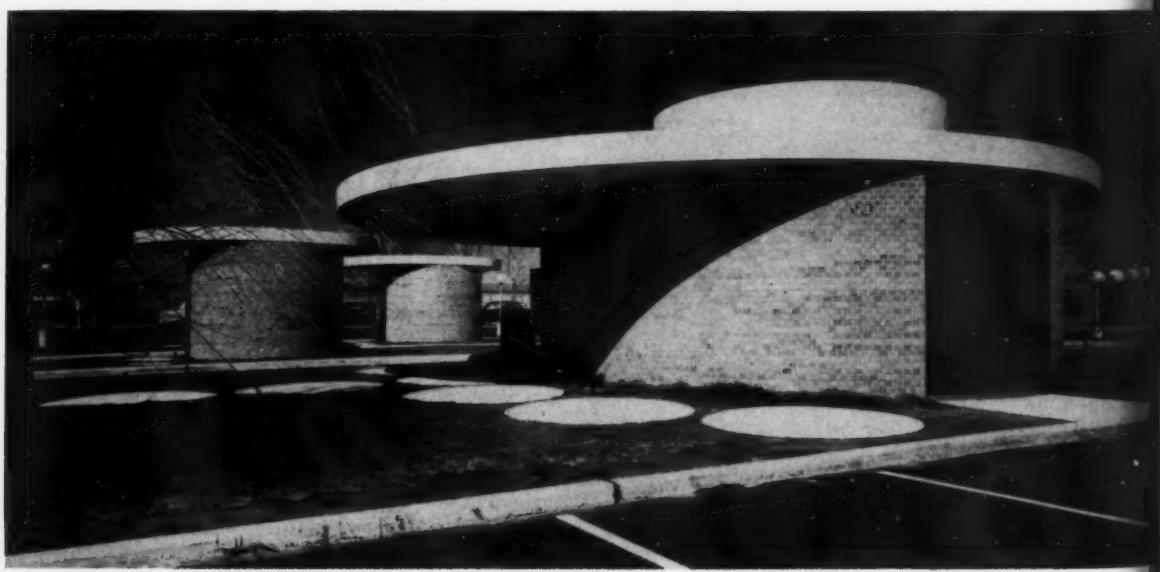
Some Work By I. M. Pei

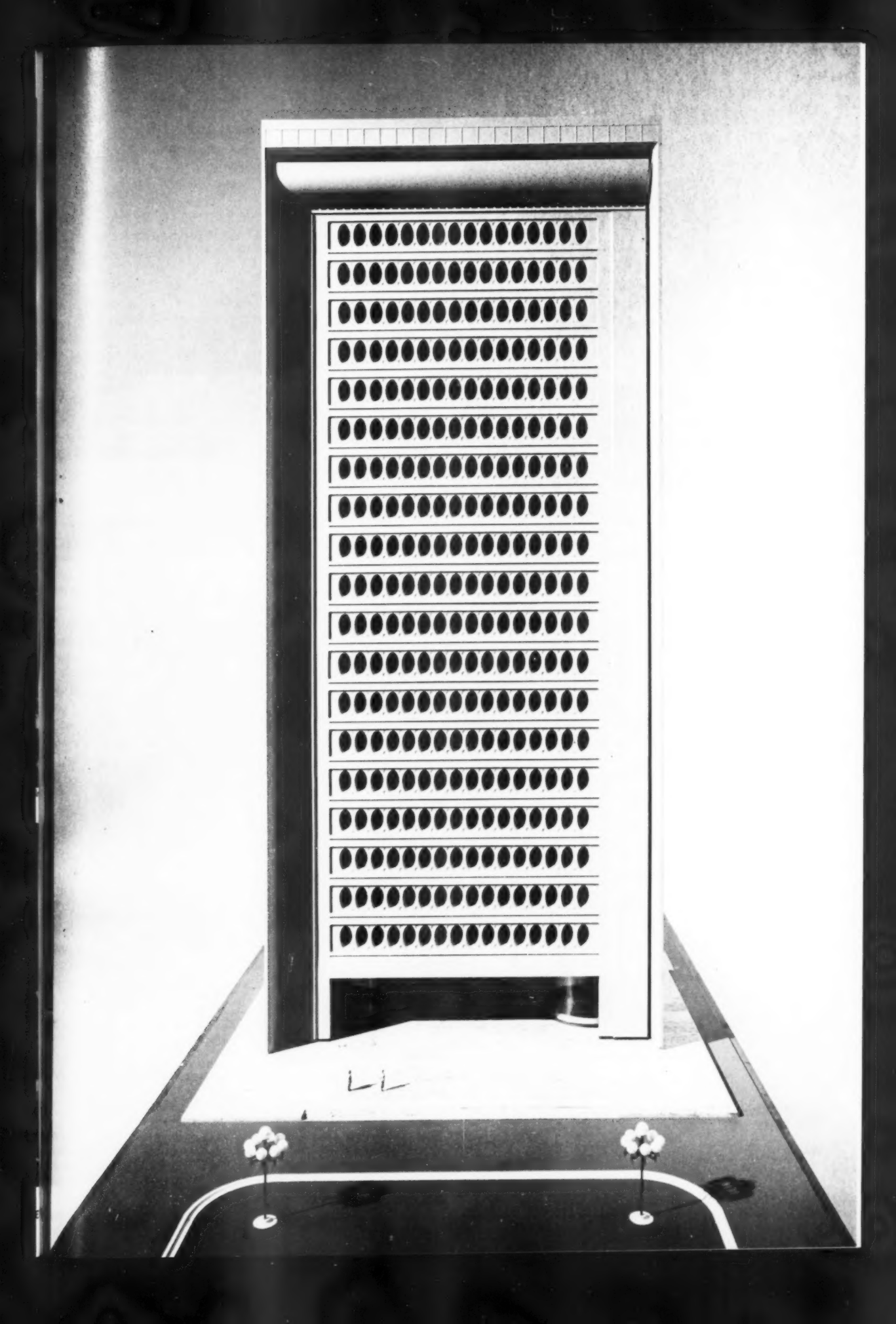


THE M.I.T. Earth Sciences building pictured on the next page, *Time* magazine recently forecast, will "act like a flagpole in a public square, drawing the surrounding laboratories and dormitories into an organized composition."

Other examples of the work of its architect, I. M. Pei, '40, are pictured on this page: Above is a Denver department store, at the right is a model of the Washington Square East Redevelopment Area on Society Hill, Philadelphia, and below is a bank drive-in center in Nassau County, on Long Island.

Photos by Warren Reynolds, George Cserna, and Ezra St





Institute Yesteryears

25 Years Ago . . .

IN THE REVIEW for January, 1936, Augustus B. Kinzel, '21, recalled that: "In 1914 two events occurred which gave to alloy steels a remarkable impetus. One was the outbreak of the World War; the second, the commercial production of stainless steel. Today, 22 years after these epochal events," he wrote, "I venture to envisage the position of alloy steels in 1944, 30 years from their coming of age, from the viewpoint of logical engineering applications and economic advantages. . . .

"The improved steels have been accepted readily by the public. Their advantages are well understood, although occasionally the materials are misapplied with disastrous results. As knowledge regarding the proper use of these steels increases, such misapplication should become a rarity, and as we gain in experience, the true field of these steels in the chemical industry, transportation, and architecture will be more clearly delineated.

"With all of the excellent characteristics, corrosion resistance being the foremost, and with freedom from some of the troubles which have limited progress in the past, the only remaining deterrent to the wide consumption of stainless steel lies in the final cost. . . . It has been stated recently that a yield of 50 per cent from ingot to sheet or other final product is the rule, rather than exception, in the production of stainless steel. With better melting practice, improvement in heating and rolling equipment, and increase in specialization in the production of these steels, we cannot help materially increasing this yield [and hence accomplishing] an appreciable reduction in the cost of the finished stainless-steel product within the decade. . . .

"We have with us at the moment a rapid development in as-rolled structural alloy steels, a relatively stable situation in the alloy engineering and automotive steels, and a situation ripe for new development and expansion in stainless steel. This would tend to lend some justification to the highly speculative prophecies for enormous tonnages of alloy steels in the not too distant future.

"Let us content ourselves, however, with the simple prediction that alloy steels in the decade will become a major item even in the large-tonnage steelmaker's portfolio, and that, together with carbon steels, they will increase the total steel consumption and effectively combat the ever-present attempted inroads of nonmetallic and nonferrous products."

¶ Kudos evidenced by medals came to four Alumni, namely, to *Charles R. Richards, '85,* the Michael Friedsam of the Architectural League of New York . . . to *George E. Hale, '90,* the Frederic Ives of the Optical Society of America . . . to *Warren K. Lewis, '05,* the Perkin of the American Section, Society of Chemical Industry . . . and to *Edward C. Wente, '14,* the Progress Medal of the Society of Motion Picture Engineers.

50 Years Ago . . .

IN JANUARY, 1911, Arthur Amos Noyes, '86, took office as the 18th President of the Alumni Association, with Frederick K. Copeland, '76, as Vice-president. Walter Humphreys, '97, was re-elected for a fifth term as Secretary-Treasurer, in which portfolio he served the Association from 1907 to 1923. The Alumni Term Members nominated for the Corporation were: Arthur Winslow, '81; Henry Howard, '89; and Henry A. Morss, '93.*

¶ The 36th Annual Banquet of the Alumni Association, held at the Hotel Somerset on January 4, was, as The Review reported, "full of genuine enthusiasm and was one of the most profitable meetings that the Association has had for many years. There were about 400 present and although the program was long, nearly every man remained until shortly before midnight when the last speaker had finished. A. Farwell Bemis, '93, the retiring President, proved himself to be a most resourceful toastmaster, and his unexpected sallies livened up the program which was, in its general nature, a serious one."

¶ It was announced that: "The tremendous increase of alumni interest all over the country has made it necessary for the Alumni Association to establish closer relations with its members, and it has therefore been decided to issue The Technology Review monthly, beginning January first [1911], excepting during the months of August, September, and October. The October number is omitted because it would contain little fresh Technology news, as the Institute does not open until that month. . . . The minimum number of copies printed during 1911 will be 4,200. . . . Although the publication of the monthly largely increases the expenses of the Association, it is believed that the enterprise will greatly add to the *esprit de corps* and will win stronger support from former students." **

62 Years Ago . . .

IN JANUARY, 1899, there was published Volume I, Number 1, of The Technology Review.

75 Years Ago . . .

"THE ELEVENTH Annual Meeting and Dinner of the Alumni Association was held at Young's Hotel on Saturday, January 2, 1886, about 50 members being present. The report of the Secretary and Treasurer was

(Concluded on page 48)

* Mr. Morss was elected a Life Member of the Corporation, in 1919; he served as the 25th President of the Alumni Association during 1918-1919.

** The monthly schedule was continued until 1918; from then until 1922 the magazine was issued quarterly. Since 1922, The Review has appeared monthly during the academic year.

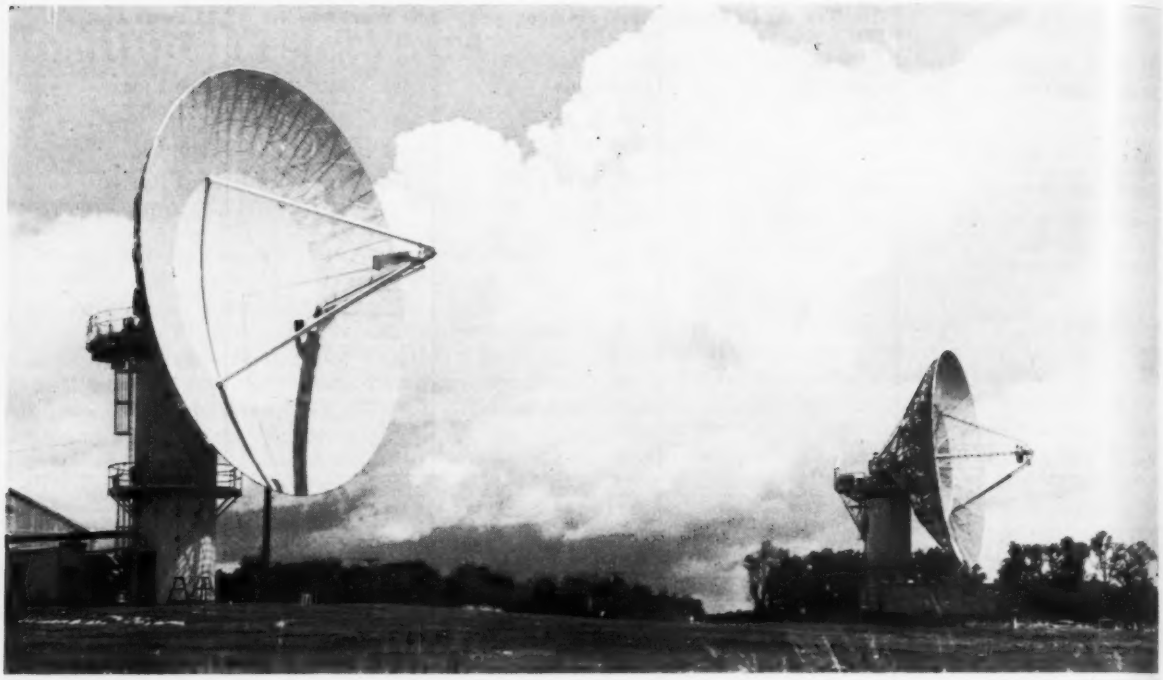
THE INSTITUTE'S GROWTH can be traced in the columns of figures on the next page, covering registration, the instructing staff, and degrees awarded. Also listed are leading states and countries from which students have come.

	One Year Ago 1959–1960		25 Years Ago 1935–1936		50 Years Ago 1910–1911		75 Years Ago 1885–1886	
	No.	%	No.	%	No.	%	No.	%
Total Registration	**6,270**	**100**	**2,540**	**100**	**1,506**	**100**	**609**	**100**
Freshmen	936	14.9	561	22.1	365	24.2	187	30.7
Other Undergraduates	2,644	42.2	1,457	57.3	1,105	73.4	422	69.3
Total Undergraduates	3,580	57.1	2,018	79.4	1,470	97.6	609	100.0
Graduate Students	2,690	42.9	522	20.6	36	2.4		
States Represented	49		45		42		34	
Massachusetts	1,565	25.0	1,088	42.8	840	55.7	387	63.5
Other New England	303	4.8	181	7.1	117	7.8	78	12.8
Total New England	1,868	29.8	1,269	49.9	957	63.5	465	76.3
Foreign Countries Represented	70		33		29		5	
Foreign Students	739	11.8	139	5.5	102	6.7	11	1.8
Total Instructing Staff	**2,010**	**100**	**529**	**100**	**246**	**100**	**62**	**100**
Faculty Members	653	32.5	245	46.3	91	37.0	27	43.5
Students per Staff Member	3.1		4.8		6.1		9.8	
Students per Faculty Member	9.6		10.4		16.6		22.6	
Total Degrees Awarded	**1,824**	**100**	**639**	**100**	**254**	**100**	**60**	**100**
Bachelor's	844	46.3 (a)	428	67.0	232	91.3	59	98.3
Master's	698	38.2 (b)	157	24.6 (d)	20	7.9	1	1.7 (f)
Advanced Engineering	83	4.6						
Doctor's	199	10.9 (c)	54	8.4	2	0.8 (e)		

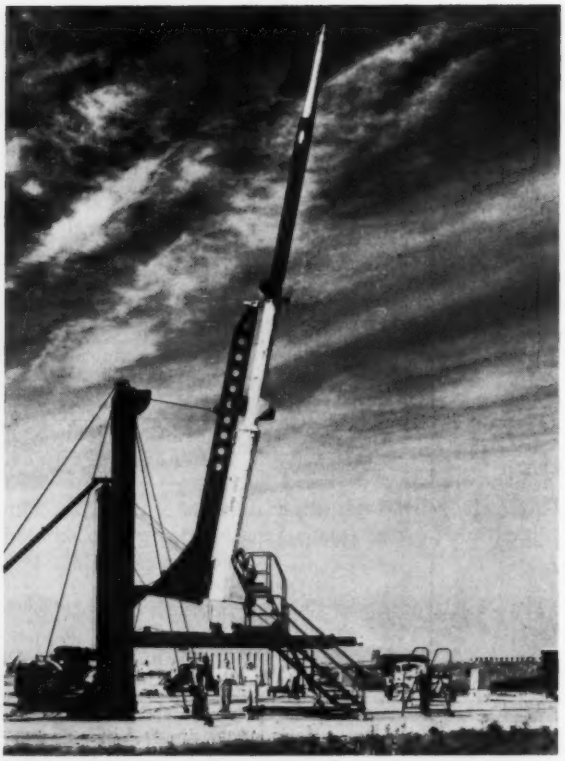
a. *First S.B. in Aeronautics & Astronautics, to Rodolfo S. Agulló, '60.*
b. *First S.M. in Aeronautics & Astronautics, to John J. Blaszak, '58.*
c. *First Ph.D. in Ceramics, to Jonathan D. Klein, '60; first Ph.D. in Mechanical Engineering, to Paul J. Berenson, '56.*
d. *First S.M. in Ceramics, to Richard O. Lane, '36; first S.M. in Petroleum Engineering, to Eldon N. Dunlap, '36; and first Master in City Planning, to J. Ross McKeever, '36.*
e. *First Ph.D. in Biology, to Eugene C. Howe, '08; and first Sc.D. given by M.I.T., in Electrical Engineering, to Reginald L. Jones, '09.*
f. *First advanced degree given by M.I.T.; S.M. in Chemistry, to Frederick Fox, Jr., '85.*

	No.	State	No.	State	No.	State	No.	State
Leading States Outside of New England	938	New York	361	New York	106	New York	20	Illinois
	348	New Jersey	143	New Jersey	37	Pennsylvania	18	Ohio
	314	Pennsylvania	104	Pennsylvania	33	Illinois	17	New York
	250	Illinois	76	Illinois	33	Ohio	15	Pennsylvania
	202	California	58	Ohio	21	California	6	Iowa
	172	Ohio	39	Missouri	18	New Jersey	5	California
	128	Michigan	38	California			5	Kentucky
	124	Florida	23	Colorado			5	Minnesota
	95	Texas	20	Maryland			5	New Jersey
			18	Michigan			5	Virginia
			16	Texas				

	No.	Country	No.	Country	No.	Country	No.	Country
Leading Foreign Countries	106	Canada	35	China	27	China	6	Canada
	63	India	29	Canada	18	Canada	2	United Kingdom
	31	China (Taiwan)	12	Cuba	9	Mexico	1	Chile
	31	France	8	United Kingdom	5	Argentina	1	Cuba
	31	Israel	6	India	5	Cuba	1	Japan
	31	Korea	5	Japan				
	25	Colombia	4	Mexico				
	24	Brazil	4	Union of South Africa				



Walloping the Atmosphere



Trailblazer I has six stages. Three carry it up to an altitude of more than 150 miles. Three others speed it back.

THE SONIC BOOM created by a jet plane going hundreds of miles an hour is trivial—a mere ripple—compared to what happens when a vehicle that is going thousands of miles an hour wallops the atmosphere. A missile or space probe approaching the earth's surface with hypervelocity makes the air as hot as the sun and turns it into a plasma, the so-called "fourth state of matter."*

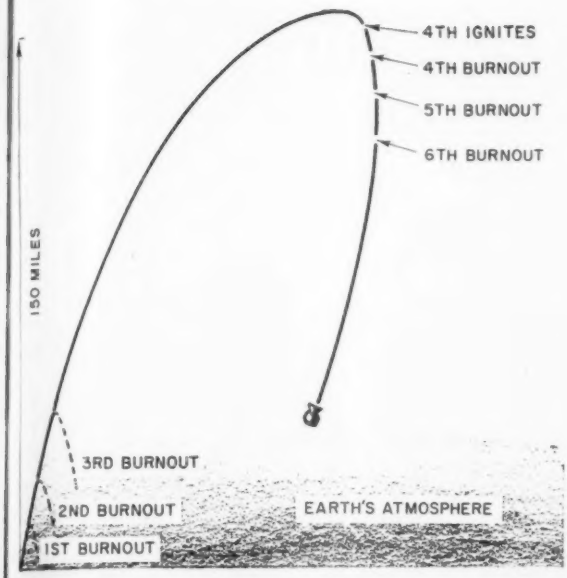
The drastic changes affect all known communication, detection and tracking techniques. M.I.T.'s Lincoln Laboratory, consequently, is studying the phenomena associated with re-entry into the atmosphere in order to:

- Assist in the solution of problems related to the nation's defense against ballistic missiles, and
- Help evolve better techniques for locating and communicating with homeward-bound spacecraft

The physics of re-entry can be studied in three ways: in theory, in the laboratory, and in the field. All three approaches have been taken. The field work, of course, is the most spectacular. This is being done now in cooperation with the National Aeronautics and Space Administration (NASA) at its Wallops Station, on Wallops Island, Va.

There, a six-stage rocket called Trailblazer I is used. It is a slender, 55-foot-long vehicle that is sent upward by three of its six stages and accelerated downward by the other three. The pay load is the sixth and final stage of the rocket itself, a sphere only five inches in diameter.

* See "Plasma Research: A Case History," by William P. Allis (Technology Review, Nov. 1960, p. 27).



Arbuckle Neck (Va.) Field Station radars track vehicles that follow course shown above. Antenna at far left on preceding page serves a combined UHF and X-band radar, while the one at right is an S-band tracking system.

Lincoln Laboratory probes re-entry phenomena with a powerful array of radars and cameras when six-stage rocket vehicles are launched

The first three stages hoist the "velocity package" from 150 to 200 miles rather deliberately. Spin-stabilized like a rifle bullet, this arrow then is aimed back toward the launching pad and an impressive array of radar and optical apparatus. The fourth and fifth stages let go only seconds apart. The spherical sixth stage then gives itself a final push. In its wake, as it hurtles down with more velocity than a bullet, it leaves a fiery trail of electrified gas. Radars and cameras probe and test the strength of this trail's radiation and reflectivity.

Including three development shots, seven Trailblazers now have been sent aloft. NASA's predecessor, the NACA, started the development of this vehicle, and it is being continued with Lincoln Laboratory's help. A second generation vehicle, Trailblazer II, will boomerang its pay load similarly, but will carry a large re-entry package and have only four stages (two to fire it up and two to accelerate it down). This rocket will be available in a few months. Soon, too, more powerful radar and sensitive optical equipment will be in operation at Lincoln's Arbuckle Neck, Va., field station adjacent to Wallops Island.

Glen F. Pippert of Lincoln Laboratory presented a technical paper entitled "The Measurement of the Phenomena Associated with Hypervelocity Re-entry into the Atmosphere" in November at the Northeast Electronics Research and Engineering meeting in Boston.

The amount of optical and infrared radiation during a flying object's re-entry and the variations in the radar signals reflected at three different frequencies are among the measurements which are being made. Tracking ra-

(Concluded on page 52)

This is a Trailblazer I ascending from NASA launching pads at Wallops Island, Va., for field study of re-entry physics.

M.I.T.'s New Agents Of Change in Africa

THE FIRST MEN chosen as Fellows in the M.I.T. School of Industrial Management's new African program were the eight members of the Class of 1960 shown above: (Left to right, in rear) *Charles H. Olmstead, Henry B. Thomas, David N. G. Carter, Donald H. Shaw,* and (in front) *John S. Glass, William P. Mott, 3d, William L. Hooper,* and *Frederick E. Mangelsdorf.* All have master's degrees. Countries welcoming their services include Uganda, Tanganyika, and Nigeria.

These men and their wives must adjust themselves to a very different environment from that in which they grew up. The wives pictured at the right are (from left) Mrs. Mangelsdorf, of Chappaqua, N.Y.; Mrs. Shaw, of Arlington, Mass.; Mrs. Mott, of Orindo, Calif.; and Mrs. Hooper, of Belmont, Mass. (Mrs. Mangelsdorf and Mrs. Shaw have studied Swahili.)

What Will Help the Ajax Company?

Africa's troubles can be compared to those of a business firm . . . M.I.T. men are there to aid

BY CARROLL L. WILSON

THE PRESIDENTS of large or rapidly growing companies, with many variables to reconcile, often think their jobs are difficult. But their tasks seem simple when compared to those of the leaders of newly independent political entities such as we see in Africa.

In the colonial administrations which preceded the establishment of these nations, authority flowed from above rather than from a consensus of those governed. This was true no matter how enlightened a colonial administration was in terms of developing institutions of self-government. Independence brought a "change of state" because this authority from above disappeared. Hence, the leaders of these new states must develop instruments of power in a new kind of framework. Even a political party is a relatively new thing in Africa.

One of the bewildering aspects of the situation in the Congo—both to an outsider and to those attempting to exercise authority—is that the leaders lack the usual instruments of power, because they have neither a well-established political party behind them nor firm control of the army and police. Moreover, the United Nations forces sent there to keep "law and order" have denied these leaders the usual courses of action which lead to the establishment of one person or another in authority —such as armed conflict to determine the victor.

In judging the performance of leaders in newly independent nations, we should try to understand the kind of problems that confront them and the difficult choices they must make. Because few of us have been political leaders but many of us have had executive responsibility in business, I am going to describe some of the problems of these new nations in industrial terms. A business case, that of the Ajax Company, may help us as an analogue:

The Ajax Management

Ajax was formerly a wholly owned subsidiary of the Hercules Company, a large, diversified company operating on a world-wide scale. During the many years that Ajax was part of the Hercules Company, the Hercules head office set all major policy and the men in managerial positions in Ajax nearly all came from other Hercules operations.

For eight or 10 years increasingly serious labor troubles plagued Ajax. About five years ago the Hercules management decided to dispose of a major part of its interest in Ajax. Two years ago Hercules transferred practically all of its interest to the present owners, retaining only a minority interest in Ajax.

The president and three of the vice-presidents of Ajax were leaders of the Ajax union during the period of severe labor troubles. They became the top management of the company when Hercules disposed of its interest. These officers have had extensive experience as labor organizers and leaders but only brief experience as managers. There has been no union since Ajax became independent, because the employees now own a controlling interest in the company. Each employee has one vote in meetings for the election of representatives and officers. According to the bylaws, the employees vote for 30 department heads who constitute a council which is the real governing body of the company. A majority of these department heads, or a coalition if there is no majority, names the president.

If a majority of the department heads meeting in council withholds approval of a management proposal, the council is dissolved. Each department head, including the officers, then seeks re-election. After the elections the new council names a president, who in turn selects vice-presidents.

Dissenting department heads have access to the company bulletin boards and public address systems as well as to the company house organ to express their criticism of the management.

The Business Outlook

Fifty per cent of Ajax's sales are of product A, a basic staple sold in world-wide markets. Labor and material costs are a high percentage of its sales value (relatively little value is added by manufacture) and the price of product A fluctuates widely; it had ranged from 280 to 130 during the last two years.

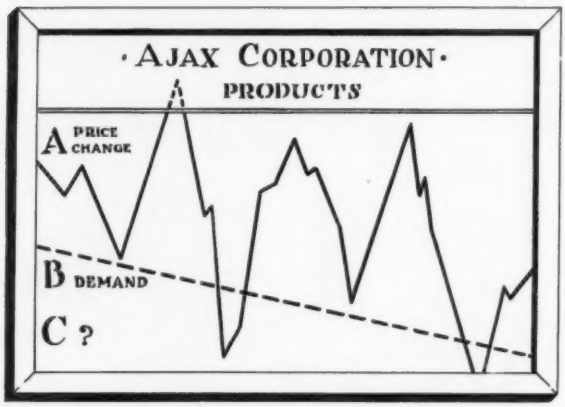
Thirty per cent of the sales are product B, another basic staple, the market for which is declining because

CARROLL L. WILSON, '32, *is now professor of industrial management (visiting). Formerly general manager of the Atomic Energy Commission, he has had extensive experience with both government and industry. He has used the case of the Ajax Company in seminars and in a talk for the Alumni Council to show the complexities of African problems.*

of competition from a competitive synthetic. Product B is produced by a number of regional units in which manufacturing methods have not changed much for many years.

One proposed new product, C, could be sold in a growing market with a stable price outlook, but setting up to manufacture this product would require a large capital investment. Most of this capital would have to be raised from outside sources.

The 30 departments' employees speak six principal languages and 40 subsidiary languages. Only department heads, superintendents, and a few foremen speak a common language. Most of the employees are illiterate. The personnel of the 30 departments is also divided among three main religious groups which have different



holidays and customs and rather intense antipathies toward each other.

The employees anticipate periodic wage increases to fulfill promises that they would benefit greatly from Ajax's independence from Hercules. The president has kept the Ajax employees well informed about the company's problems and its progress. At his request a year ago the employees accepted postponement of a wage increase so that the company might strengthen its financial position in the hope of attracting the capital needed to produce the new product C. A major problem of the Ajax management is to increase productivity, so that Ajax products will not be priced out of the world markets in which they are sold.

The industry's condition is one of great fluidity. There is a great deal of maneuvering for mergers, acquisitions, and combinations of various kinds. There are no antitrust laws or other legal restraints.

There is an industry association which meets as a whole for several months each year and in committees during much of the year. The industry association's headquarters are in a city remote from Ajax's headquarters, and the president or the vice-presidents in charge of sales and finance must spend much of their time on affairs of the industry association.

The Immediate Situation

Prices of product A have fallen below the break-even point, necessitating lay-offs in 10 departments and resulting in acute distress among employees. Two dissident department heads are going to bring before the council a proposal to raise wages and fringe benefits. If it is adopted over the objections of management, the management will fall. Such an increase will tend to price the Ajax products out of their markets.

A number of consultants have been retained in the past two years, and one has just prematurely published findings critical of the management. This is the second or third time that consultants have provided ammunition for dissident department heads to use against the management.

Two giant companies, Prometheus and Aeolus, both of which are larger than Hercules, are making numerous offers to help Ajax by offering training programs, setting up new departments, advising on production and sales, or lending money at low rates. Prometheus is a tight-line organization with an impressive record of growth, but it has taken over companies it has offered to help in the past. Prometheus does an excellent planning and programming job and can cite excellent ratios of overhead costs to direct costs. Aeolus is a very loosely organized company with consultative management, many committees, and poor planning. It is a rich firm that has helped others without absorbing them. But Aeolus always urges companies which it helps to adopt exactly the same organization and management programs which it uses.

Aeolus has numerous informal groups within it which are so loosely connected with the company that they are able to make arrangements without any reference to the management of Aeolus. They can be hired as consultants and to perform services. Ajax can accept or reject their advice without getting into difficulties with Aeolus as a company.

Stability Brings Credit

As is customary in presenting a business case, we do not provide the answers. It is clear, however, that the instability of management, growing out of the strange and difficult features of the bylaws, makes it virtually impossible for any management to take the kind of actions that are needed, including those which are unpopular, and still have sufficient opportunity to carry out a wise program.

In a like fashion, the leaders of new nations, looking at the parliamentary institutions which they borrowed from the colonial powers, find numerous limitations in them. Hence, they often move to amend the bylaws to provide greater continuity and stability for their regimes. One such action leads to another to make the power of those on top more secure.

Justifications for such steps, which seem to outsiders to have the earmarks of emergent dictatorship, are found in many directions. All the African nations, for example, need capital from the outside for economic development programs. But countries which have weak and changing governments do not attract outside investors whether they are private firms or such institutions as the World Bank. Nations with strong and secure governments are generally better credit risks.

In the case of the Ajax Company the president could very well conclude that, in order to raise the capital for the plant needed to produce product C, he must convince the lender that his government is both prepared and able to balance its budget, honor its commitments, and fulfill the repayment provisions. This would require the strength to take unpopular actions such as resisting the proposed wage increase. Such a program

would obviously lead, if successful, to much greater prosperity and security for the employees of Ajax, but the immediate sacrifices required from them might be substantial.

Another problem which confronts the president of Ajax is where to turn for help. With Prometheus (as with the U.S.S.R.), all deals with it must be official, and made through the front office. But Aeolus (which resembles the United States) has unofficial groups—private institutions of all sorts—with which the president of Ajax can make deals quite independently of the official organization.

An American Advantage

An African nation can make or terminate arrangements freely with private institutions, whereas official aid through official channels is hard to cancel without giving offense. Herein lies a very important advantage for the United States. It is not only an advantage in meeting the variety of needs of these new nations but also a competitive advantage vis-a-vis the U.S.S.R.

Our private financial institutions, business organizations, and especially our educational institutions operating with the support of great foundations, permit us to meet various needs of these new nations in a variety of ways and do so quite unofficially. We can, if we wish, move expeditiously and imaginatively in exploiting these opportunities.

Last October, for example, a plan to send M.I.T. Fellows to Africa was announced. After receiving master's degrees in the School of Industrial Management, eight young men embarked upon two-year tours of duty as employees of institutions in three African countries. The institutions employing them are engaged in various economic development activities. This idea originated in a class which I conducted the first term of last year and took shape about the middle of January. The opportunity arose from my observations in Africa in the summer of 1959. It seemed to me then that one of the great needs in Africa was for people with technical and business training. The new African organizations had plenty of advisers, consultants, and employees of other governments available to advise and assist. But they needed employees of their own to formulate new projects, prepare applications for assistance, and review and allocate resources. With a growing amount of aid likely to be forthcoming, the bottleneck might prove to be the scarcity of people, within the local governments and related institutions, able to select and prepare the cases and process them.

Men receiving their master's degrees in Industrial Management at M.I.T., many of whom would have an undergraduate engineering education, seemed exceptionally well qualified to serve as staff assistants in such organizations. The enthusiastic response of the class led to the steps which were taken. Financial support was assured by the Ford Foundation, and a trip to London and to several countries in Africa resulted in identifying and working out arrangements for positions for M.I.T. men in Uganda, Tanganyika, and Nigeria.

Arrangements were completed by the middle of April, 1960. This speed was possible only because of the willingness of the employers in the African countries to deal directly with a private American institution, reserving in every case the right of termination on relatively short notice if the arrangement did not work.

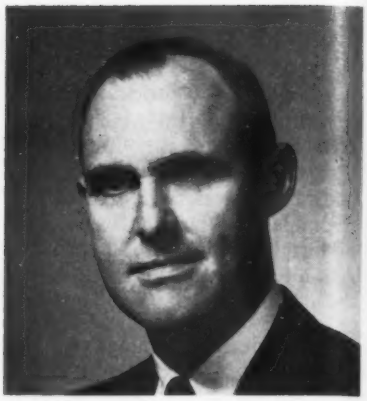
The program is modest in scope but the men are located in quite strategic positions. The contributions they will be able to make will depend largely upon the vigor of the institutions by which they are employed and the extent to which their bosses find ways of using them. Much initiative is called for. The M.I.T. men must adjust themselves to living and working in a very different culture from that in which they grew up. As "agents of change," moreover, they will be active participants in a process that is poorly understood. The program will be reviewed in Africa early this year to determine how it is going and the directions in which it might be extended.

The number of Americans who can be absorbed in such a program will be very small in relation to the needs. It is essential, therefore, that all who go be the best that we produce.

These parts of the world have seen missionaries, occasional mining engineers, and government officials, but young Americans such as the M.I.T. Fellows are a new phenomenon. Even a few such men, appropriately placed at a time of great fluidity and change, can have an important impact on the development of these nations and their relations and feelings towards this country. The M.I.T. Fellows in Africa are conscious of the importance of their missions. Their performance will reflect credit both upon M.I.T. and the United States.

An apartment house in Dar es Salaam, Tanganyika, Africa.

Four Economists Foresee An Industrialized World



FOR SEVEN YEARS, *Professor Charles A. Myers (at right) and several of his colleagues in the M.I.T. Industrial Relations Section have been participating in an Inter-University Study of Labor Problems in Economic Development, for which the Ford Foundation provided financial assistance. Several books have resulted from this study. One of them,* INDUSTRIALISM AND INDUSTRIAL MAN *(Harvard University Press, $6), has been summarized as follows by Derickson Bennett of the Harvard News Office:*

FOUR ECONOMISTS expect an acceleration of industrialism around the world that "in another 100 years will have swept away most pre-industrial forms of society." They predict that, in spite of different leadership in the industrialization process—by the middle class, nationalist leaders, colonial administrators, revolutionary intellectuals, or old families—there will be a general convergence of East and West on the road to industrialism.

Signs of this convergence are already evident, the authors say: a middle class bureaucracy is developing in some nations of the East; central governments of some Western states are assuming more and more responsibilities. As this convergence continues, the authors foresee in most nations a powerful central state, a crucial role for the middle class (or in some areas, the middle bureaucracy), man governed by a web of rules and united within interest groups to protect his rights, great conformity on the job, and a new freedom of leisure.

How industrialism will affect mankind's future is charted in *Industrialism and Industrial Man,* by four leaders in labor economics: Clark Kerr, President of the University of California; John T. Dunlop, Professor of Economics, Harvard University; Frederick H. Harbison, Professor of Economics, Princeton University; and Charles A. Myers, Professor of Industrial Relations, M.I.T.

"To predict the future with any accuracy," these writers say, "men must choose their future . . . The future they appear to be choosing and pressing for is pluralistic industrialism . . . where there is one locus of power, there will come to be several; where there are many, there will come to be fewer."

The Central Forces

The authors cite three central forces that will mark the push toward industrialism in this form:

¶ In the name of efficiency and initiative, some decentralization in the consumer goods and service trades industries is necessary, but there will be a large measure of central control by the state and responsibility for the conduct of many operations by large-scale organizations.

¶ Skill level rises and jobs become more responsible . . . with this skill and responsibility go the need for consent, and with consent goes influence and authority. Occupational and professional groups achieve some prestige and authority as against both the central organs of society and the individual members of the occupation or profession.

¶ Education brings in its wake a new economic equality and a consequent new equality of political outlook; the universal industrial mass. This helps bring consensus to society. Education brings a demand for liberty and can help create conditions in which it is safe to give it.

These forces—complexity of industrial society, higher skill levels, and universal education—foster a "new realism" that rejects both utopia and hopeless despair, the economists say.

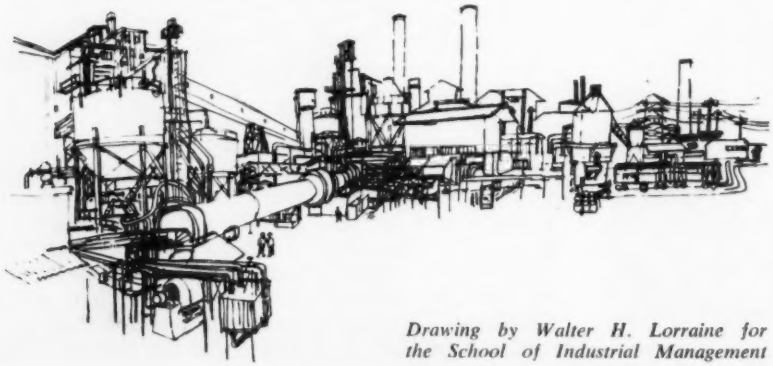
This new realism accepts industrialism as a complicated mechanism that must be kept going without major disruption. It calls for new relations between the managers and the managed. The labor force accepts the web of rules and pace of work, and the managers push less hard. The sense of protest subsides; the conflict of ideologies is blunted.

Some Basic Rules

While the courses which nations follow toward industrialism may vary, the authors foresee some basic "rules" which will apply to all nations:

"The State That Does Not Wither Away. The state will be powerful. It will, at the minimum, have the responsibility in an industrial society for the rate of growth of the economy, the over-all distribution of income, the basic security of individuals, provision of essential public services . . . All of these

(Concluded on page 50)

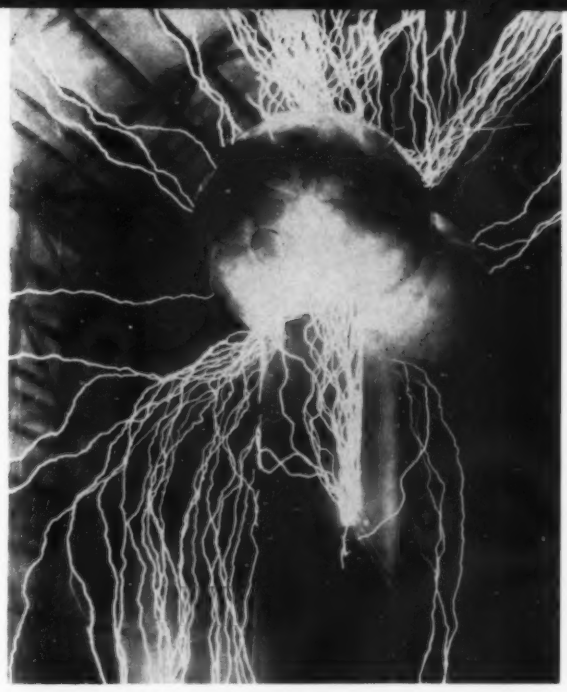


Drawing by Walter H. Lorraine for the School of Industrial Management

Van de Graaff Electrostatic Generators

The prodigious feats of the first huge machines are exceeded by smaller accelerators now . . . in the world's great nuclear research laboratories and many of its finest hospitals and universities

BY J. J. ROWLANDS
Editorial Associate of The Review



The generator's great power was demonstrated in the 1930's.

DURING a critical stage of World War I, Sir Ernest Rutherford was summoned to France for an emergency meeting on antisubmarine warfare. He begged a delay on the ground that he believed he was about to succeed in breaking the atom apart. Such a discovery, he was quoted as saying, might well be more important than the war itself. Although he failed in his original objective, he made a discovery of great importance when he drove protons from the nuclei of nitrogen, aluminum, and several other elements, and produced chemical transmutations.

Sir Ernest's triumph launched an intensive search for methods of attacking the citadel of the atom—its tiny, positively charged nucleus. Armed with laboratory weapons of various kinds and with only fragmentary knowledge of their prey, scientific hunters ranged far and wide on the trail of the agile and elusive nuclei. The searchers' only effective bullets were the energetic alpha particles spontaneously emitted by radioactive material. These alpha particles were few in number and lacked the speed and impact to penetrate the high-voltage cocoon enclosing the nuclei of the heavier atoms.

A call for a new weapon came in Rutherford's presidential address to the Royal Society in 1928 when he emphasized the urgent need for "a source of positive particles more energetic than those emitted from natural radioactive substances." Such a siege gun of science would have to deliver an abundant, reliable stream of nuclear-sized projectiles with energies sufficient to shatter nuclei. For precise studies the particles would have to be homogeneous, uniform in energy, and producible in a parallel beam with a minimum of stray radiation. Furthermore, it would be important to accurately measure and control over a broad range the voltage by which such particles were accelerated.

Guides were few and most of the pioneers following the dim trails of particles, the nature of which they could only guess, hewed their own paths in the atomic wilderness. Among them was Chadwick of Cambridge, who discovered the neutron. Bothe, working in Germany about the same time, also found the trail of the neutron but mistook it for a photon. Cockcroft and Walton, armed with the first nuclear particles accelerated by a laboratory-size machine, achieved and demonstrated the transmutation of lithium into helium in 1932. Their projectiles were created by ionizing hydrogen and applying high voltages for acceleration. By then, the pace of discovery was quickening.

Van de Graaff and Compton

Robert J. Van de Graaff of Tuscaloosa, Ala., was graduated from the University of Alabama in 1923. He was 22, had completed the requirements for a bachelor of science and a master's degree in five years, and was still hungry. After a year of advanced study at the Sorbonne in France, he won a Rhodes scholarship and went on to Oxford University. Rutherford's atomic calls to arms echoed through the cool stone halls of the English universities and Van de Graaff's interest became all-consuming. In 1926 he was awarded the bachelor of science degree, and in 1928 his doctorate in philosophy. After another year at Oxford as an International Education Fellow, he went to the Palmer Physics Laboratory at Princeton as a National Research Fellow for two years.

During this period Van de Graaff was in regular communication with Karl T. Compton, then chairman of the Department of Physics at Princeton and about to become president of M.I.T. Dr. Van de Graaff clearly had joined the atom hunters, and in Compton he found a close personal friend as well as a staunch scientific colleague.

As early as 1930 Dr. Van de Graaff not only predicted the type of transmutation later achieved by Cockcroft and Walton, but calculated that the transmutation would result in an energy release of 17,000,000 electron volts, which subsequently proved to be

accurate. He was searching then for a source of high-voltage particles—the fast, hard-hitting projectiles that Rutherford had called for.

Electrostatic Principles

In 1799 Volta built the voltaic cell which, while useful, held no promise as a source of high voltages. Faraday discovered electromagnetic induction in 1831, and about the same time Joseph Henry discovered self-induction, marking the dawn of our present electrical age. At the beginning of the Twentieth Century, however, static electricity had become a subject of little more than historic interest to be revived from time to time as a parlor trick.

Concluding that the extremely high voltages required for atomic research could not be produced by batteries or electromagnetic methods, Van de Graaff's thinking turned back to the electrostatic principles—and the experiments of Thales of Miletus, who in 600 B.C. found that a bit of amber vigorously rubbed against other substances would attract feathers and other light materials.

Otto von Guericke, in 1663, devised an electrical machine made of globes of sulphur which rotated about an axis. Rubbing these globes separated electrical charges and produced a high voltage. Isaac Newton afterwards used a glass globe instead of sulphur. Ramsden, in 1768, constructed an electrical generating machine with a plate-glass disc rotating between two leather pads. Friction caused the glass to become positively charged while the pads were negatively charged; the charges were taken off and conducted to insulated terminals when the glass rotated between combs with very fine points.

Lord Armstrong of Newcastle accidentally discovered another source of static electricity in 1841 when a jet of steam from a leaking boiler struck a piece of metal, giving him an electric shock. Lord Armstrong later built a steam electrostatic generator. Belli, Varley, Toepler, and Hertz also produced generating devices, and in 1872 Lord Kelvin built his Replenisher, a device with a rotating arm making contact with electrodes. Then, about 1878, came the Wimshurst machine, an instrument with glass discs rotating in opposite directions, which was long used in schoolrooms to demonstrate electrostatic principles.

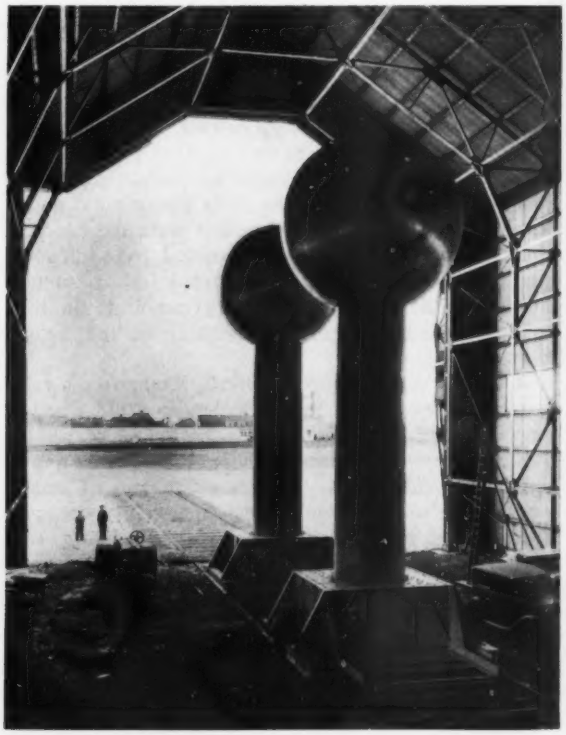
The First Model

In static electricity Dr. Van de Graaff saw the promise of constant high voltage which he could not find in either the battery or electromagnetic generation. His first generator was based on the theory of Lord Kelvin's device, in which drops of water carrying small electrical charges fell into cups, where the charges accumulated as the drops continued to fall. But, instead of water, Van de Graaff used moving silk belts, carrying charges vertically, to be stored on a spherical metal terminal supported by an insulating column.

Dr. Van de Graaff built his first model of a direct-current electrostatic generator in the summer of 1929. The charges were sprayed on the belt at the base of the generator. The belt carried them upward and into the sphere where they were removed. This generator, made from tin cans and a silk ribbon, developed 80,000 volts.

A more elaborate model with terminal spheres two feet in diameter, standing on pyrex columns six feet high, was completed a few months later. Two such gen-

Robert J. Van de Graaff (left) with President Karl Compton.



The Round Hill generator was set up in a dirigible hangar.

erators, one running positive and the other negative, developed over a million volts between their terminals.

This machine was first demonstrated in public on November 10, 1931, at a dinner of the newly organized American Institute of Physics in New York. There Karl Compton hailed Dr. Van de Graaff's machine as "the most important development that has ever taken place in the field of extremely high voltages." He saw the new generator as a siege gun for a major attack on the nuclei of atoms, and also forecast that the extremely high-voltage direct currents producing highly penetrating x-radiation would be of significant value in the treatment of deep-seated malignant disease.

The Round Hill Machine

The next step was construction of a huge Van de Graaff machine at Round Hill, the estate of the late Colonel E. H. R. Green, at South Dartmouth, near New Bedford, Mass. A building of extraordinary size was required, and Colonel Green made a dirigible hangar available to enclose two huge generators. The terminal aluminum spheres 15 feet in diameter were on cylindrical textolite columns 24 feet high, and the two generator units were mounted on rails 14 feet apart so that the distance between the terminals could be adjusted. Charges were deposited on the spheres by three paper belts, each three feet wide, running at a speed of almost a mile a minute.

The Round Hill generator developed more than 5,000,000 volts between its terminals, and Dr. Compton called attention to the machine's value by contrasting its output with that of radioactive sources.

The press was taken to Round Hill to see this giant on November 28, 1933. To show the high-voltage discharges, the machine was operated until the breakdown of open-air insulation produced spectacular discharges to the roof and walls of the building. These discharges, 15 to 20 feet long, Dr. Van de Graaff explained, would not occur under normal operating conditions, but they produced startling photographs.

One newspaperman, with a better background in physics than his colleagues, asked permission to be placed in one of the huge terminal spheres while the machine was in operation. His associates watched in awe as he disappeared through the manhole at the base of the sphere. He saw none of the spectacular discharges but had a different story to tell.

Penetrating X-Rays

The Round Hill machine was dismantled later and moved to Cambridge, where it was housed in somewhat more compact quarters under a steel dome. It was used there for studies of the intricate structure of atomic nuclei for the next 20 years.

Early in the second World War, Dr. Van de Graaff and his associates applied the generator to the production of penetrating x-rays for the examination of heavy castings and other essentials of the military effort. The ability of megavolt x-rays to produce radiographs showing the internal structure of thick metal pieces was so great that the Institute was asked to construct five 2,000,000-volt x-ray machines, insulated in compressed air, for the Navy.

The particular physical properties of the penetrating x-rays produced at 2,000,000 volts have given medicine a powerful and valuable instrument for the treatment of deep-seated malignant tumors. Precision control of the voltage and the diameter of the beam with an absence of scattering has made it possible to focus the beam on malignant tissue with far less damage to the sensitive skin and intervening tissue than would be the case with conventional x-rays.

A versatile, 3,000,000-volt machine now weighs only 9 tons.

Until the Van de Graaff generator was developed, the highest steady voltage ever produced was 800,000 volts. The present generators capable of producing several million volts require evacuated tubes of special design to apply such high voltages to the acceleration of electrified particles. High evacuation is necessary to avoid energy-dissipating collisions with molecules of gas in their passage through the tube. The design of a tube of this type requires that the field along the insulating walls of the tube be controlled and that the walls be sheltered from stray ions that might result in flashover or puncture. Such tubes, evacuated to the highest possible degree, provide an environment in which charged particles of specific types can be accelerated to high energy and sent out of the tube in parallel paths in a beam of small diameter.

Reductions in Size

For the Huntington Memorial Hospital in Boston, Dr. Van de Graaff and John G. Trump, '33, built a machine, operating at more than a million volts in atmospheric air, with which the first patient was treated early in 1937. This machine occupied a room only about 25

feet square, and produced the first megavolt x-rays for therapy in the New England area.

Early in the development of the electrostatic generator, however, it became apparent that both voltage and current, as well as power output, could be increased by placing the generator in an insulating medium better than air at atmospheric pressure. In a paper on high voltage in 1933, Dr. Compton noted that a generator operating in a tank of gas at 30 atmospheres of pressure should, in theory, produce 30 times the voltage, 30 times the current, and 900 times the power that could be developed in open air. While Dr. Van de Graaff was working on his second generator, a colleague at Princeton, Henry A. Barton (who went on to a distinguished career with the American Physical Society), built a small generator to operate in compressed gas.

This procedure has been a major factor in designing small and highly efficient Van de Graaff electrostatic generators. The second medical x-ray generator—far more compact than the Huntington Memorial machine, since it was insulated in compressed gas—was built for the Massachusetts General Hospital under a grant from the Godfrey M. Hyams Trust. This machine was only 50 inches high, the terminal and tank diameters 24 and 34 inches, respectively, and it operated with a single 14-inch belt. It went into operation in April, 1940, at the George Robert White Building. Operating at 1,250,000 volts, it was for a time the only megavolt x-ray source for therapy in New England.

The next compressed-gas-insulated machine for therapy, operating at 1,750,000 volts, was built for the American Oncologic Hospital in Philadelphia. It was requisitioned by the U.S. Army for radiation damage studies as part of the bomb program at the University of Chicago. A replacement x-ray generator built for the Oncologic Hospital is still in use. This machine was the prototype of the 2,000,000-volt medical x-ray generators which, with a number of refinements, now are in more than 40 hospitals throughout the world.

World-Wide Usage

It is estimated that more than 800 patients are treated daily with the radiation these machines provide. The Van de Graaffs produce penetrating electromagnetic radiation physically and biologically equivalent to the gamma rays of radium. The rays from a single machine, however, have an output intensity twice that of the world's supply of radium.

A comparison of the Round Hill generator as it was reassembled in Cambridge with modern 2,000,000-volt machines dramatizes the reduction in size resulting from use of gases under pressure for insulation. The volume of the pressure tank of a modern machine is less than one-thousandth that of the steel building that enclosed the Round Hill machine, and a single belt six inches wide nowadays carries nearly the same current as the early machine's three-yard-wide belts.

A compressed gas generator that operates in the 10,000,000-volt range was completed at M.I.T. in 1952, and has proven especially valuable for fundamental nuclear studies. William W. Buechner, '35, directs the research program in which it is used.

The demand for the Van de Graaff generator for nuclear research long ago outgrew the capacity and purpose of the M.I.T. laboratory in which it was developed. With a group of colleagues, Dr. Van de Graaff and Dr. Trump formed the High Voltage Engineering Corporation in 1947. It has installed more than 160 accelerators in universities, national nuclear laboratories, hospitals, and chemical research plants throughout the world.

The particles used as projectiles in great accelerators gain their energy either by repeated application of small voltages or the single application of a constant voltage, as in the Van de Graaff generator. Although the latter has distinct advantages in precision, and beam intensity and flexibility, it has been limited to relatively low-particle energies because of the single application of the voltage to speed the particles on their way. Recent developments, however, have shown that the principle of tandem acceleration can be employed to apply voltage two, three, or even four times to accelerate the ions, and thus increase the positive-ion output energy.

In tandem acceleration the output energy for medium-weight particles is increased manyfold by stripping electrons from the ion beam. Machines of this type have been delivered to several of the world's famous atomic research laboratories. The High Voltage Engineering Corporation is building a 100-million electron volt, 40-kilowatt, microwave linear accelerator for the Bureau of Standards now.

In 1959, High Voltage Engineering and the B. F. Goodrich Company formed a jointly owned subsidiary called Goodrich-High Voltage Astronautics, Inc., which is interested in the development of advanced propulsion systems and methods of power conversion for the exploration of outer space. It may well be that, when man conquers space, vehicles equipped with machinery employing the principle of the Van de Graaff generator will soar from the earth into galactic space.

Van de Graaff radiation processing improves many materials.

Books

ADVENTURES IN ALGEBRA, by Norman A. Crowder and Grace C. Martin, and THE ARITHMETIC OF COMPUTERS, by Norman A. Crowder (two "Tutor-Texts" published by Doubleday & Company, each $3.95). *Reviewed by Philip Franklin, Professor of Mathematics at M.I.T., in the same manner in which both books were written.*

1. Like the newly developed teaching machines, each of these books is an automatic teaching tool. The format is aimed to insure that an attentive and conscientious reader who follows instructions and reaches the last page will necessarily have a considerable understanding of the subject treated.

To this end, information is offered in small units. At the end of most units there is a question, with several suggested answers. A direction as to which item of the book is to be read next is given with each answer. By choosing a particular answer as best in his opinion, the reader automatically selects what he reads next, and thus sequentially determines his progress through the book. *To illustrate the format of the books, the sections of this review are numbered. They are not necessarily to be read in consecutive order, but rather in accord with the directions given at the end of most sections.* **Please follow that direction which corresponds to the answer you select.**

Which of the following statements best represents your reaction to automatic teaching methods?

(a) I have no interest. (Stop reading this review, and turn to some other item in this magazine)
(b) I have some interest. (Read section 3 next)
(c) My interest has already led me to read the two books under review. (Read section 5 next)
(d) I am interested. I am familiar with Crowder's *TutorText* method, but not with the contents of the two books under review. (Read section 4 next)

☆ ☆ ☆

2. You did not follow the instruction corresponding to your answer to the question at the end of Section 1. Please reread the emphatic admonition given before this question.

☆ ☆ ☆

3. The object of the special arrangement of material, questions, and directions of these texts is to set up a course of reading individually programmed for each student by his choice of answers. The questions are designed to test his grasp of the item discussed. A best answer shows that he is prepared to start a new unit, and he is so directed. An incomplete answer, or one obtained by a misunderstanding or an illegitimate procedure, leads to an item explaining why the answer was incorrect or incomplete, and then referring the reader back to the original question for a second try. Some wrong answers show that the reader has forgotten or ignored definitions of terms or symbols given earlier, and the reader is advised to reread these.

Thus when the reader grasps the point at once, he skips much irrelevant (to him) further explanation and elaboration. But the slower learner, or less attentive reader, will find profitable the explanations of common errors and the rereading of definitions which are called to his attention when he needs them.

Is it intended that the user of these texts should read all the material in consecutive order?

(a) No. (Read section 4 next)
(b) Yes. (Reread section 3 with closer attention, and then choose the other answer)

☆ ☆ ☆

4. "Adventures in Algebra" deals with elementary algebra. The nature of numbers is stressed, and much technique is carefully explained. Such topics as prime numbers and mathematical induction are included, and presented in terms accessible to readers with very modest mathematical preparation. These topics should add to the interest of adults using the book to refresh their school algebra. The book should prove useful to school children beginning algebra as a supplement to their school work. And their parents, who remember how to use algebra but do not recall how one starts the subject, may be helped by this book.

"The Arithmetic of Computers" reviews decimal arithmetic, and then treats octal and binary arithmetic. Thus it proceeds from an analysis of the use of ten as a base, to an arbitrary base, and in particular the use of eight as a base and then two as a base. Some details of the treatment of signed binary numbers by digital computers are explained in the last quarter of the book. (Read section 5 next)

☆ ☆ ☆

5. Both books give greater emphasis to reasoning and a grasp of principles than was customary in older school books. They include some topics under consideration for a place in recently revised mathematics curricula. Unlike many teaching machine sequences, they do not overemphasize drill. For mature readers with average self control, or immature readers with very little advice and supervision, books of this type should be an inexpensive alternative to teaching machines, having many of the advantages of a teaching machine sequence.

In these two books the programming idea is carried out with great technical skill. The breezy comments, compliments, and scoldings with occasional humor or satire make it easy for the reader to imagine that he is being talked to by a teacher. The choice of material for these books demonstrates that the writers are well versed not only in algebra and arithmetic as elementary subjects, but also in their foundations, applications, and connection with advanced mathematical topics. And the multiple-choice questions and answers, as well as the remedial items to which one is led by choosing a distractor, indicates that the authors have had sufficient experience in personal teaching of these subjects to be familiar with most of the mistakes commonly made by beginners.

(Book news is continued on page 38)

DIGITAL COMPUTER FUNDAMENTALS, by Thomas C. Bartee, of M.I.T. Lincoln Laboratory; McGraw Hill Book Company ($6.50). *Reviewed by F. J. Corbato, '56, Associate Director of M.I.T. Computation Center.*

COMPUTATION by high-speed computers is rapidly growing and there is still a shortage of explanatory books. As computers have a larger and larger effect and impact on contemporary life, it is encouraging that books are appearing which bridge the gap between the research laboratories and the intelligent layman.

Advances have been so rapid in computing that already there are two groups of specialists. One group, the designers and builders, is concerned primarily with "hardware." This group continually strives for clever circuits, faster switching, cheaper memory devices, reliability, and generally faster techniques.

The other group, the system programmers, have become primarily concerned with the utilization of digital computers. Fundamentally digital computers perform logical operations such as adding, subtracting, comparing, skipping an instruction if the result is negative, etc. In principle, it is fairly obvious that exceedingly complex sets of instructions called programs can be devised to accomplish any well-specified task. In practice, however, it has been found that straightforwardly preparing these basic machine instructions is hopelessly tedious and time consuming. As impressive as computer applications have been they are still limited by programming clumsiness. In the past few years programming techniques have begun to evolve using new programming languages that are more succinct and potent than the previous ones. The general problems of designing these languages and developing the corresponding translators to the fundamental machine language form an active area of current programming research.

The present book is primarily a description of computers written from the "hardware" point of view. Chapter 1, *Computer Operations,* is concerned with a brief historical summary and a few examples of applications that serve to motivate the usefulness of a computer. Chapter 2, *Programming,* is also brief, but it is a clearly written, short description of the fundamental ideas of programming. Chapter 3, *Number Systems,* introduces the notion of different representations of numbers and particularly, binary, binary-coded decimal, one's complementing and two's complementing.

The first three chapters are a fundamental introduction. Chapter 4, *Basic Logical Circuits,* is directed not only at the casual reader but at the serious student as well. OR-gates, AND-gates, inverters, flip-flops, binary counters, the race-problem, and other related topics are developed using transistor circuits. (It is a measure of the thinking in the computer world that vacuum tubes are beginning to be treated as obsolete equipment!) Chapter 5, *Logic Design,* gives a straightforward application-oriented presentation of Boolean algebra along with DeMorgan's Theorem and other manipulation principles for developing the necessary switching circuits of computers.

The remaining chapters cover the design of the key computer sections. Chapter 6, *The Arithmetic Element,* is an extended treatment of this vital part of the computer. As the author points out, "arithmetic element" has become almost a misnomer and the term "logical element" would be a better description. Chapter 7, *Memory Element,* discusses the basic features of core memories as well as magnetic drums, tapes and discs. Chapter 8, *Input-Output Devices,* is a survey of the common tape and card readers, printers, cathode-ray tube output, and other similar devices. Chapter 9, *The Control Element,* discusses the execution of typical operations and how various complexities such as floating-point arithmetic are handled.

Science Fiction at M.I.T.

HUGO GERNSBACK, a man with both an abundance of reminiscences and a mission, was a guest last fall of the M.I.T. students' Science Fiction Society. Many Alumni will recall his name as that of the publisher of *Radio-Electronics* and author of *Ralph 124C 41+*. Mr. Gernsback regaled the young men in his audience with stories of Nicola Tesla's pigeons and told them, too, about the "Westing Mouse vest-pocket radio" for which he himself received 2,000 orders at a time when no such thing existed. But he also pointed out that the Russians have discovered science fiction only recently, and he pleaded seriously for a renaissance in this art in this country.

Today's outstanding authors of "scientifiction," said Mr. Gernsback, are: Dr. Arthur C. Clarke, Dr. Isaac Azimov, Robert A. Henlein, A. E. van Vogt, Clifford D. Simak, Theodore Sturgeon, and Hal Clement. But, he insisted, science fiction is "the domain of youth," and the M.I.T. Science Fiction Society "could easily become the leader of an important new movement in science fiction."

At the right, Mr. Gernsback is shown autographing a book for Anthony R. Lewis, '61.

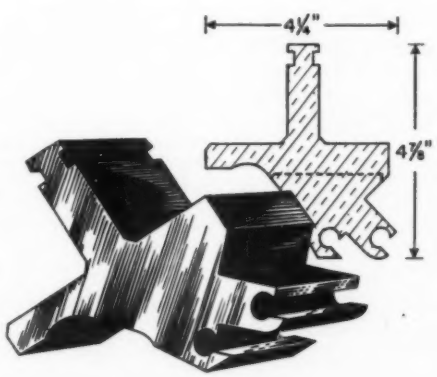
(Book news is continued on page 40)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

The extruded copper section sketched below is used in a low-voltage circuit breaker made by one of the country's leading electrical equipment manufacturers.

Originally it was two extrusions brazed together as shown by dotted line. However, it was reasoned, if it could be made as a single extrusion a number of operations would be saved. At first that procedure appeared to be impractical in a copper extrusion as intricate and heavy as this (piece of it only $3\frac{7}{16}$" long, measuring $4\frac{1}{4}$" x $4\frac{7}{8}$", weighs eight pounds, seven ounces). But the possibility was believed to be worth investigating.



Through close collaboration between the manufacturer's engineering department and the Revere Methods and Production Departments, it was found possible to combine these two sections into a single extrusion. Work was started, dies were made and test runs conducted. The tooling (for hot extrusion was followed by cold drawing) also posed some special problems. It had to be both rugged and precise in order to produce this monster extrusion to the manufacturer's exacting specification requirements.

Finally, a sample extrusion was delivered to the customer for testing and found to be right in every way.

Not only does this Revere Copper Extrusion eliminate much costly machining in the customer's plant, but it obviates the need to purchase separate extrusions and braze them together. An extra benefit was gained in the form of longer life for the new extrusion, because the heat required to join the two pieces used originally had tended to soften the built-up unit and thus shortened its useful life.

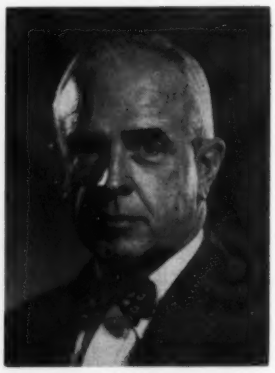
So, while some problems may seem virtually insoluble at first, why not explore the possibilities by doing as this leading manufacturer did . . . call on the Revere Technical Advisory Service? In that way, by "fitting the metal to the job," Revere may be able to help you to cut costs, produce a superior product, or both.

In fact, it generally pays to adopt that principle with all suppliers—take them into your confidence; thus add their abilities and experience to your own.

REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
Executive Offices: 230 Park Avenue, New York 17, N. Y.
Distributors Everywhere

POSTWAR ECONOMIC TRENDS IN THE UNITED STATES, Edited by Ralph E. Freeman, Professor of Economics, Emeritus, M.I.T. (Harper & Bros., $6). *Reviewed by David S. Greenlaw, '57 Sloan Fellow, of Eastman Kodak Company, Rochester.*

FROM time to time an economist writes a book. Quite often these volumes represent contributions to the literature. They are read mostly by other economists. If, by chance, a businessman, engineer, or industrial manager wanders very far into one of these books he may become frustrated, a little annoyed, and eager to return to familiar if not solid ground. Books by economists for economists are necessary. They are rarely useful for the moderately informed, active, industrial, professional person.



Ralph E. Freeman

Frequently, too, an economist writes a book for broad public consumption. Many times in recent years these books have been persuasive, incisive, and devoted to the exposition of a point of view. Whether aimed at historical perspective or the forecasting of events to come, such books are usually free from data, not in the least bit technical, and limited to the breadth of vision of a single person.

Between the textbook by economists for economists and its counterpart in popular economic literature lies a wide valley. In this valley most professional industrial people spend their lives. *Postwar Economic Trends in the United States* is for the people in the valley.

The book contains ten essays, each by a different author or author team. Each essay is a thoughtful and provocative analysis of certain factors which combined to produce the economic development of the United States after World War II. Each of the essays is strengthened by the presentation of data and facts prior to the analyses.

Each author knows the others on more than a casual or "conference" basis. The authors are or have been associated in the Department of Economics and Social Science and the Center for International Studies at M.I.T. Many of the arguments presented have been tested, reworked, strengthened, and developed during the building of a great center and a great department.

A synergistic effect results from crossing and weaving the threads of individual thought arising from different backgrounds of scholarship and interest. The result is a single fabric of inquiry—coherent, scholarly, and readable. Here is no flip book hastily put together. It urges the reader to think carefully and read thoroughly. The book assumes a grasp of something like first and second-year economics plus an interest in the subject. Armed with some basic concepts, the reader is not likely to be overwhelmed.

Listing the authors and the subjects of their essays should elicit a curiosity on the part of many potential readers who have been so busy with daily problems that they haven't read anything very serious in the field of economics.

"The Dynamics of American Society" by W. W. Rostow deals with the changes in American domestic life including the domestic crisis of 1956-1958. Professor Rostow delineates new forces at work in the 1960's which offer arguments for both affluence and austerity for the future. The changing goals of the American economy are developed after pointing out the social forces that have shaped this change.

"American Economics" by Paul A. Samuelson begins with early American economics and recalls some of the first American writers in this field. Professor Samuelson spells out the development, in the United States, of a competence in the technology and science of modern economics. Fom this newly evolved capability within the United States comes the recognition of some problems.

"Postwar Monetary Policy" by Ralph E. Freeman begins with the economic heritage of war and depression, and outlines step by step the action of the U.S. Government through the several changes in monetary policy. Professor Freeman reconstructs the situation and forces which placed monetary policy in eclipse. He then describes the factors responsible for a revival in monetary policy and offers a judgment of its future importance.

"Income Inequality Since the War" by Robert M. Solow focuses on a subject dear to the heart of every professional person who now feels that his economic status has been gradually eroded by taxes and industrial wage policy so that no differentiation in income remains among the widely diverse contributions of individuals. Professor Solow carefully documents his arguments to analyze the degree to which the postwar period has shown a redistribution of income.

"Federal Fiscal Policy in the Postwar Period" by E. Cary Brown carefully picks apart and delineates federal fiscal policy as viewed with the specular clarity of hindsight. The effectiveness of fiscal policy in dealing with the postwar inflation, the recessions of 1948 and 1957, and the inflationary periods is carefully reviewed. In the background are questions regarding what was actually done and what might have been done.

"Continuity in Change in American Labor Problems" by Abraham J. Siegel and Charles A. Myers. The executive dining rooms of most American industries have from time to time echoed with the sterling thought that inflation and arrested economic growth have been caused by an avaricious labor movement whose irresponsibility is deplorable. Professors Siegel and Myers carefully review American labor problems in the recent past and offer a look ahead for the 1960's.

"Development, Diversification, and Decentralization" by Alfred D. Chandler, Jr. The evolution of a new pattern of competition among firms in different industries making the same product is discussed and described. The implication of the modern diversification in multi-industry activities which has altered the older patterns of business competition is carefully set forth for the major industry groups firm by firm. Here is a careful restatement of the position to which firms have evolved during the postwar period, which

(Continued on page 42)

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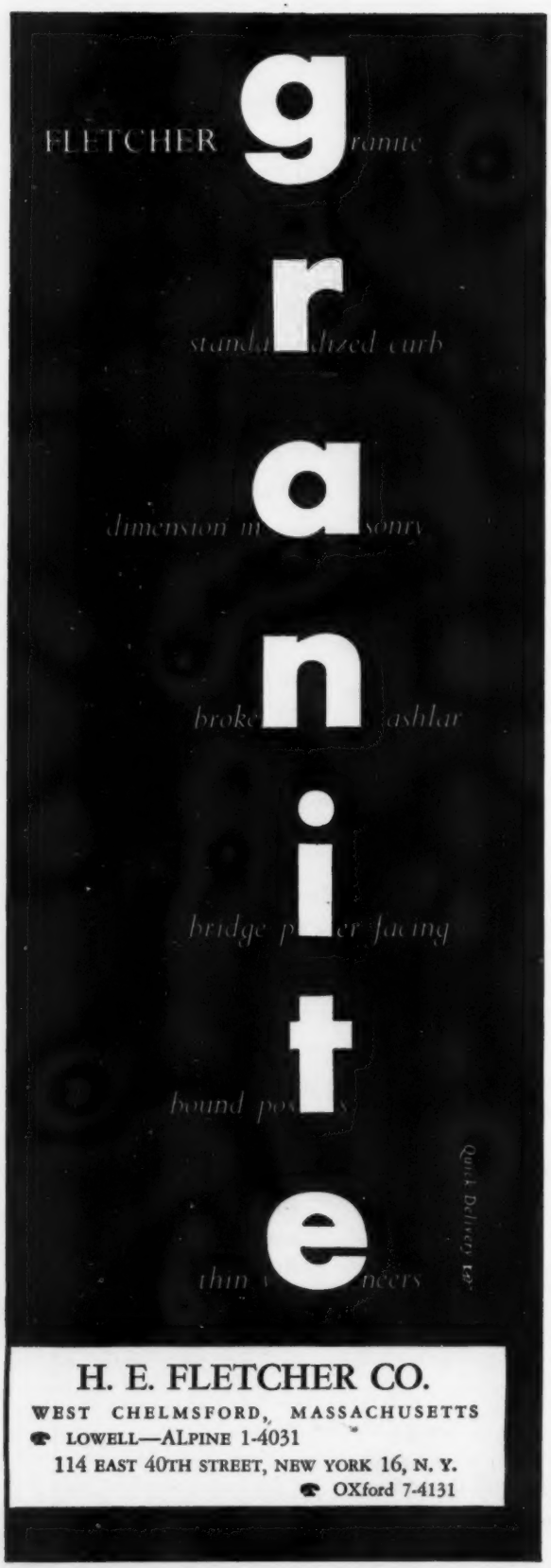

Books

(Continued from page 40)

is different from the stereotyped pattern carried by many of us.

"Some Aspects of Corporate Enterprise" by M. A. Adelman develops the analysis and argument that during the postwar period a polarization of capital and labor, and the size and fewness of firms, have made corporations politically weaker rather than stronger.

"A Decade of Corporate Capital Investment: 1946-1955" by Eli Shapiro and Morris Mendelson. In this period under review, the United States corporations managed the greatest absolute level of capital growth that has ever been experienced in the country. The manner in which this growth was financed, and its result in terms of the condition in which corporations found themselves after the expansion had been completed, are carefully analyzed and set forth. An abundance of charts and data assist in describing what well may be a modern economic miracle.

"International Trade and United States Experience" by Charles P. Kindleberger is quite properly the last essay. It turns attention to the position of the United States in foreign trade. Here Professor Kindleberger follows the well-worn trail of the model of comparative advantage as far as it will go, but then does not hesitate to strike off on his own to describe the experience of several major industries in the field of world competition. Tariff history and suggested cause-and-effect relationships are spelled out.

At the end of each chapter in the book there are notes and references which should lead the interested and competent inquirer to a busy winter of economic study and review.

It is almost as if Ralph Freeman had worked hard to bring together men of independent yet complementary and competent scholarship and had asked them to write a book. With several authors, each specializing in his own field of comparative advantages, the book gives an insight into the subject which is deeper, broader, and clearer than would be obtained if the reader studied the scholarship of any one author. Perhaps it is no coincidence that the book produces this impression. It is precisely from this background that the book has come. Ralph Freeman was the head of the Department of Economics during its formative years and has had more than a little to do with assembling an academic team whose strengths are complementary and whose scholarship individually and in the aggregate is competent. Ralph Freeman's team wrote the book.

DYNAMIC PROGRAMMING AND MARKOV PROCESSES, by Ronald A. Howard, '55; The Technology Press of M.I.T. and John Wiley and Sons, Inc. ($5.75). *Reviewed by Thomas C. Bartee, Lincoln Laboratory, M.I.T.*

THIS MONOGRAPH presents an introduction to two subjects in the field of operations research: dynamic programming and Markov processes. The volume is slim (136 pages), but the pace is lively, and the book covers considerable material. Further, the presentation is

(Concluded on page 44)

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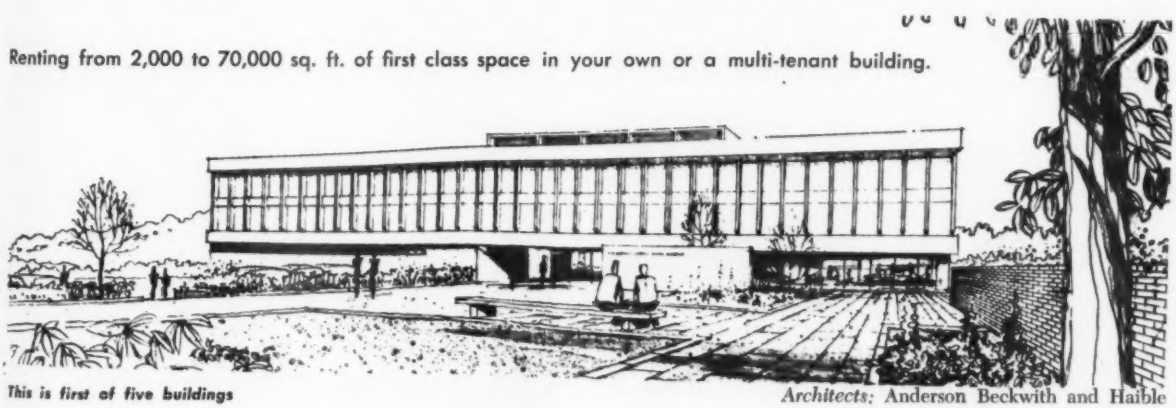

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Books

(Concluded from page 42)

very clear and may be easily followed by readers with no prior knowledge of the field. At the same time the book should be of value to those interested in the use of Markov processes as system models, for both dynamic programming and Markovian models are sufficiently recent subjects that an introductory book can present original and novel material.

The subject matter for the book was taken from an Sc.D. thesis in Electrical Engineering, and is also based on work done at the M.I.T. Computation Center and the M.I.T. Research Laboratory of Electronics. The basic problem is that of analyzing a system which can be considered to be in one of a finite number of states at a given time, and for which conditional probabilities may be assigned to each of the possible transitions from state-to-state. After explaining an analysis technique based on use of the z-transform, the author describes Markov processes with rewards, considering rewards assigned to states and state transitions in various ways. The decision problem is then introduced, where the operators of the system are offered several courses of action, and the choice of policy (strategy) will change the transitions probabilities and rewards governing the process. Two computational schemes for determining an optimal policy are then presented. The first, *value iteration,* appears more desirable for short-duration processes, and the second, *policy iteration,* better for long-term (continuous-time) processes.

Professor Howard has made excellent use of the technique of explaining new ideas by means of illustrations. The reader of this book will find himself guided through the use of z-transforms in analyzing discrete Markov processes by means of a problem confronting a toymaker, and introduced to policy iteration via a problem in strategy confronting a baseball manager.

Because of the straightforward approach, a surprising amount of material concerning the use of mathematical models and dynamic programming in the solution of sequential problems is presented.

This book may be very profitably read by those in the operations research field, and will impart a surprising amount of useful theory, painlessly acquired, to all interested readers.

A NEW COMPUTER, an IBM 1620, a small, solid-state machine with a magnetic core memory, has been installed in the Civil Engineering Computer Laboratory. Frank L. Sillay, '64, helps Professor Charles L. Miller, '51, use it.

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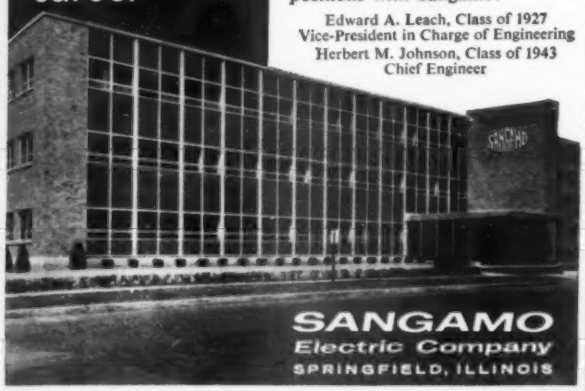

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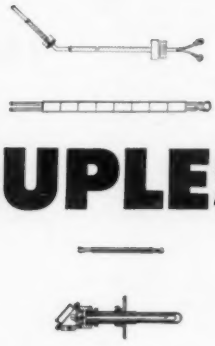

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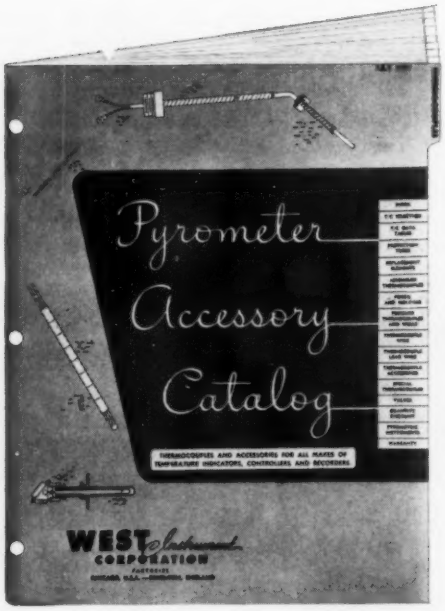

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Individuals Noteworthy

(Concluded from page 8)

Visiting Professor

FRED W. BILLMEYER, JR., senior research chemist in the Polychemicals Department of E. I. du Pont de Nemours & Co., Inc., is a visiting professor this term in the M.I.T. Department of Chemical Engineering.

A graduate of California Institute of Technology, he received his doctorate from Cornell, and has been with the Du Pont Company since 1945. He is the author of many technical papers on polymer chemistry and a textbook which is widely used. In addition to teaching this term, he is helping Professors Alan S. Michaels, '44, and Edward W. Merrill, '47, who are developing a new course which the Department will offer next term.

New Neighbors

L. DENNIS SHAPIRO, '55, heads a new firm, Aerospace Research, Inc., at 90 Massachusetts Avenue, Cambridge, which will engage in research and development in radio propagation and ionospheric physics. Robert B. Craven, '55, is in charge of instrumentation, and Melvin M. Weiner, '55, is a member of a staff consultant advisory group.

William E. Barbour, Jr., '33, is president of another new corporation, Magnion, Inc., located at 195 Albany Street, opposite M.I.T.'s new Magnet Laboratory. It expects to engage in research and development of magnetic systems and products.

Fellows From Abroad

THE SCHOOL for Advanced Study now has 10 Sloan Foreign Post-Doctoral Fellows working in eight M.I.T. Departments. They are:

Robert Blinc, Chemistry, from Yugoslavia; *Fausto Calderazzo,* Chemistry, from Italy; *Y. B. Damle,* Economics, from India; *Karl Fischer,* Crystallography, from Germany; *Allan E. Mitchell,* Mechanical Engineering, from England; *Kazuo Noda,* Industrial Management, from Japan; *Toru Ogawa,* Physics, from Japan; *Clive H. Perry,* Mechanical Engineering, from England; *Hiroshi Tanaka,* Mathematics, from Japan; and *Herta von Dechend,* Humanities, from Germany.

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Institute Yesteryears

(Concluded from page 24)

read, showing a balance on hand January 1, 1886, of $59.83. The report of the trustees of the Alumni Fund was read and accepted, the report showing the amount at hand to be $1,133.27. . . . The annual election of officers was then held, and the following were elected to the offices indicated: Howard A. Carson, '69, President; Henry M. Howe, '71, Vice-president; George F. Swain, '77, Secretary. . . ."

¶ The Editor of *The Tech* took notice of the approaching end of the first semester, and entered a plea on behalf of "cramming," to wit:

"The much-dreaded semi-annuals are now at hand, and the traditional midnight oil and wet towels are in order. 'Cramming' is almost universally considered, by those who do not have to do it, as not only injurious to health, but also an illegitimate method of getting a good standing.

"When one writes home how hard he is 'grinding' during the examinations, how late he is sitting up at night, and other tales of woe, paterfamilias will probably reply that he sees no reason why he need be obliged to study so excessively before the examinations if he had given sufficient attention to the subjects when he first went over them, together with other remarks of like nature. This seems to be a popular impression among those who do not know anything about it. . . .

"While a long period of habitual midnight study would soon undermine a man's health, a few days of it, with an interval of rest afterward, will not seriously harm anyone of good average constitution. We might even go so far as to say, that there are certain advantages to be derived from it. . . .

"The one direct advantage gained from cramming is perhaps its discipline. The art of acquiring in a short time a good general idea of a subject is a great accomplishment, and one which few possess; yet this is what this much-abused process of cramming does for us.

"It trains the mind to open itself, as it were, and take in a very great deal at once, and to be accustomed to so doing . . ."

¶ And, in an adjoining column of *The Tech,* appeared this notice: "It is said that the issue of free railroad passes is a source of corruption among State legislators. If any Instructor will give us a free pass on Railroads, Applied Mechanics, and one or two other little things, we will corrupt him to any desired extent."

100 Years Ago . . .

ON JANUARY 11, 1861, under the leadership of William Barton Rogers, there took place in the Mercantile Building, 16 Summer Street, Boston, a meeting of persons interested in the formation of an institute of technology. An "Act of Association" was adopted, reading in part as follows:

"*Resolved:* That a Committee of Twenty, with power to increase their number, be appointed to represent the interests and objects of this Association, and to act generally in its behalf until it shall be legally incorporated and regularly organized under the title and according to the purposes of the Massachusetts Institute of Technology. . . ."

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An Industrialized World

(Concluded from page 32)

responsibilities mean that the state will never 'wither away': that Marx was more utopian than the despised utopians."

"The Crucial Role of the Enterprise—The Middle Class and the Middle Bureaucracy. The productive enterprise under pluralistic industrialism will be in a dominant position . . . the managers, whether public or private, will be professionals . . . distinction among managers will be more according to the size, the product, and the nature of their enterprise . . . the middle class and the middle bureaucracy will look much alike."

"Associated Man. The occupational or professional association will range alongside the state and the enterprise as a locus of power in pluralistic industrialism . . . class warfare will be forgotten and in its place will be the bureaucratic contest of interest group against interest group. The battles will be in the corridors instead of the streets, and memos will flow instead of blood."

"The Web of Rules. Uniting these organizations—the state, the enterprise, the association—will be a great web of rules set by the efforts of all the elements but particularly the state . . . the web will not equally cover all aspects of life."

"From Class War to Bureaucratic Gamesmanship. Persuasion, pressure and manipulation will take the place of face-to-face combat of an earlier age . . . Conflict will be less between the broad programs of capital and labor, and of agriculture and industry; and more over budgets, rates of compensation, work norms, job assignments."

"From Class Movement to Special Interest Group. The day of ideological labor movements as we have known them will have passed . . . Labor organizations will take the craft or the occupational form . . . the professional organization may become the most common kind of organization like those of doctors, lawyers, teachers, nurses, airline pilots in many countries already . . . generally these occupational and professional organizations will be a conservative force in the society."

"Organization Man and the New Bohemianism. The individual will be in a mixed situation . . . in his working life he will be subject to great conformity imposed not only by the enterprise manager but also by the state and by his own occupational association. . . .

"The economic system may be highly ordered and the political system barren ideologically; but the social and recreational and cultural aspects of life diverse . . .

"Utopia never arrives, but men may well settle for the benefits of a greater scope for freedom in their personal lives at the cost of considerable conformity in their working lives.

"Pluralistic industrialism will never reach a final equilibrium. The contest between the forces for conformity and for diversity will give it life and movement and change . . . these threads of conflict will continue when class war, and the contest over private versus public initiative, and the battle between monistic and atomistic ideologies have been left far behind in the sedimentary layers of history."

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SUN LIFE ASSURANCE COMPANY OF CANADA is pleased to announce that the initial response to its Values in Education series has been more than gratifying. Hundreds of thousands of booklets have been distributed on request to all parts of the United States and Canada. These booklets, which are still available, deal with the advisability of remaining in school; existing scholarships and student loan programs; trade and industrial schools; school boards and their functions, and sports tips for teen-agers. Bulk shipments can be made to educators for distribution in schools.

Sun Life is now offering a further series of booklets in its Values in Education series. 'How to Get More Fun out of School' is directed to the young teen-ager. It is hoped that 'The Value of a College Education' and 'Why Study the Humanities?' will encourage young men and women to attend university and help them in their search for their proper vocation. Two booklets have been prepared for adults—'Adult Education Today' and 'Educating Yourself for Retirement.'

Sun Life hopes sincerely that these booklets, and others to be issued in the future, will act as a stimulant on young people and at the same time prove helpful to parents and educators alike in the performance of their duties. Sun Life will be glad to consider any suggestions concerning topics for future booklets.

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Walloping the Atmosphere

(Concluded from page 27)

dars equipped with extensive facilities for data processing and recording can pinpoint the five-inch sphere more than 200 miles away. These are being backed up by optical devices, including meteor cameras, a Schmidt spectrographic camera, and ultimately a 48-inch spectrometric telescope. Still more measurements are being provided by the radar equipment at Lincoln's Millstone Hill site near Bedford, Mass.

Lincoln Laboratory's theoretical and experimental research guides this field work. The former includes investigations of the shock phenomena that occur when a vehicle with hypervelocity enters and travels through the earth's atmosphere, the electronic characteristics of the plasma sheath that is formed and left in the wake of the vehicle, and techniques for determining the flow field with electromagnetic probes. In laboratory set-ups preliminary to the field work small projectiles are fired at re-entry velocities up to nearly five miles a second. This is done in ballistics facilities both at NASA's Ames Research Center and at Lincoln Laboratory.

The work is sponsored by the Advanced Research Projects Agency under a contract with the U.S. Air Force.

NEXT MONTH in The Review, Professor Douglas McGregor will discuss far-reaching changes in the strategy of management necessitated by the growth of science, industry's increasing complexity, and the changing composition of its working force.

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and the prophet replied:
*"It is well to give when asked, but it is better to give unasked, through understanding."**

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The tale is told of Almustafa, the prophet, who, having awaited for many years the ship that would return him to the place from whence he came, was making the final descent to the shore when the folk of Orphalese crowded about him. They besought him before departing to "disclose us to ourselves, and tell us all that has been shown you of that which is between birth and death."

With words of wisdom, an answer appropriate was given to the woman holding a baby, to the ploughman, to the merchant. Begged one, "Speak to us of GIVING," and the prophet replied:

> "It is well to give when asked, but it is better to give unasked, through understanding;
> And to the open-handed the search for one who shall receive is joy greater than giving. All you have shall some day be given;
> Therefore give now, that the season of giving may be yours and not your inheritors'."

Through the years the prophet's words have held true, for even today he who "through understanding" includes the MASSACHUSETTS INSTITUTE OF TECHNOLOGY as a beneficiary in his will can experience thereby a two-fold satisfaction. The successful culmination of his search for a worthy recipient and the anticipated results his generosity will assist in accomplishing. These satisfactions give an added value to the span of man's days and protect his usefulness to his fellowmen far into the future.

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* The "Prophet" by Kahlil Gibran

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Technical Books

RECENTLY announced publications likely to be of especial interest to M.I.T. Alumni include:

Analog and Digital Computer Technology, by Norman R. Scott, '40, Professor of Electrical Engineering at the University of Michigan, a text suitable for self-study (McGraw-Hill Book Company, Inc., $12.75).

Crystal-Structure Analysis, by Martin J. Buerger, '24, Professor of Mineralogy and Crystallography at M.I.T. (John Wiley & Sons, Inc., $18.50).

Foundations of Electrodynamics, by Parry H. Moon, '27, Professor of Electrical Engineering at M.I.T., and Domina E. Spencer, '39, Associate Professor of Mathematics, University of Connecticut (D. Van Nostrand Company, Inc., probably $7.50).

Frequency-Power Formulas, by Paul L. Penfield, Jr., '60, of the M.I.T. Research Laboratory of Electronics (The Technology Press of M.I.T. and John Wiley & Sons, Inc., $4).

High Speed Testing (Vol. 1), a symposium co-chairmanned by A. G. H. Dietz, '32, Professor of Building Engineering, M.I.T., and Frederick R. Eirich, Polytechnic Institute of Brooklyn (Interscience Publishers, $5).

Introduction to Mechanics, Matter and Waves, by Karl Uno Ingard, '50, and William L. Kraushaar, Associate Professors of Physics at M.I.T. (Addison-Wesley Publishing Company, $9.75).

Methods of Regional Analysis, by Walter Isard in association with Gerald A. P. Carrothers, '59, and others (The Technology Press of M.I.T. and John Wiley & Sons, Inc., $9.50).

Nuclear Fusion, edited by William P. Allis, '23, Professor of Physics at M.I.T., reporting significant ideas on fusion presented at the 1958 conference in Geneva (D. Van Nostrand Company, Inc., $12.50).

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UP TO DECEMBER 1, total of 38,-023 Alumni—over 70 per cent of those to whom announcements of the forthcoming publication of the 11th edition of the MIT ALUMNI REGISTER were sent last May—had checked and returned the enclosed IBM card thus verifying the data for the individual's listing in the new book.

Such an unprecedented response, far in excess of the optimistic hopes of the undersigned editors, ensures that in *completeness and accuracy* the 1961 REGISTER will surpass the high standards set by its predecessors.

INCLUDING present Alumni and the 1959-1960 student body, the *Alphabetical-Living* section of the 1961 REGISTER will contain an estimated 56,000 names—each with Class numerals, Course, all MIT degrees received . . . and with address, position held, and firm name *wherever it has been possible to obtain such verified information.*

During November, editorial work on the *Alphabetical-Living* section was completed, and we began sending copy to the printer. Since this main section will extend over 360 pages of text, it has been agreed that no further changes are to be made once a listing has been set in type. To do otherwise would disrupt pressroom and bindery timings and seriously delay the appearance of finished cloth-bound books.

WHEN TYPE-SETTING on the *Alphabetical-Living* section is finished, the data cards will be re-sorted to obtain copy for the section in which the names will be cross-referenced *Geographically.*

The new book also will contain other sections as follows:

(1) *Members of the Corporation since 1862,* over 430 names with dates of service.

(2) *Members of the Institute Faculty and Staff since 1865,* over 12,650 names with the Institute Departments in which they served or are serving, and their dates of service.

(3) *Officers of the Alumni Association since 1876,* with positions held, and their dates of service.

(4) *Deceased alumni,* now totalling more than 14,105, whose names will be listed alphabetically with numerals in a complete roster.

PRESS-WORK on the final portions of the book is scheduled to commence in February, five weeks being allotted to the printer before finished copies are to start emerging from the bindery. Thus, we expect to fulfill all *advance orders* by April 10, the Institute's centennial anniversary date.

PRODUCTION of a 650-page reference work such as the forthcoming 11th edition of the REGISTER is an expensive undertaking. Nevertheless, in order to secure a wider distribution of the 1961 REGISTER – which will list 14 per cent more alumni than the book of 1955 – the Executive Committee of the Alumni Association established a cash discount for advance orders accompanied by payment at $7.50 per copy post paid. The post-publication price will be $9.00 per copy.

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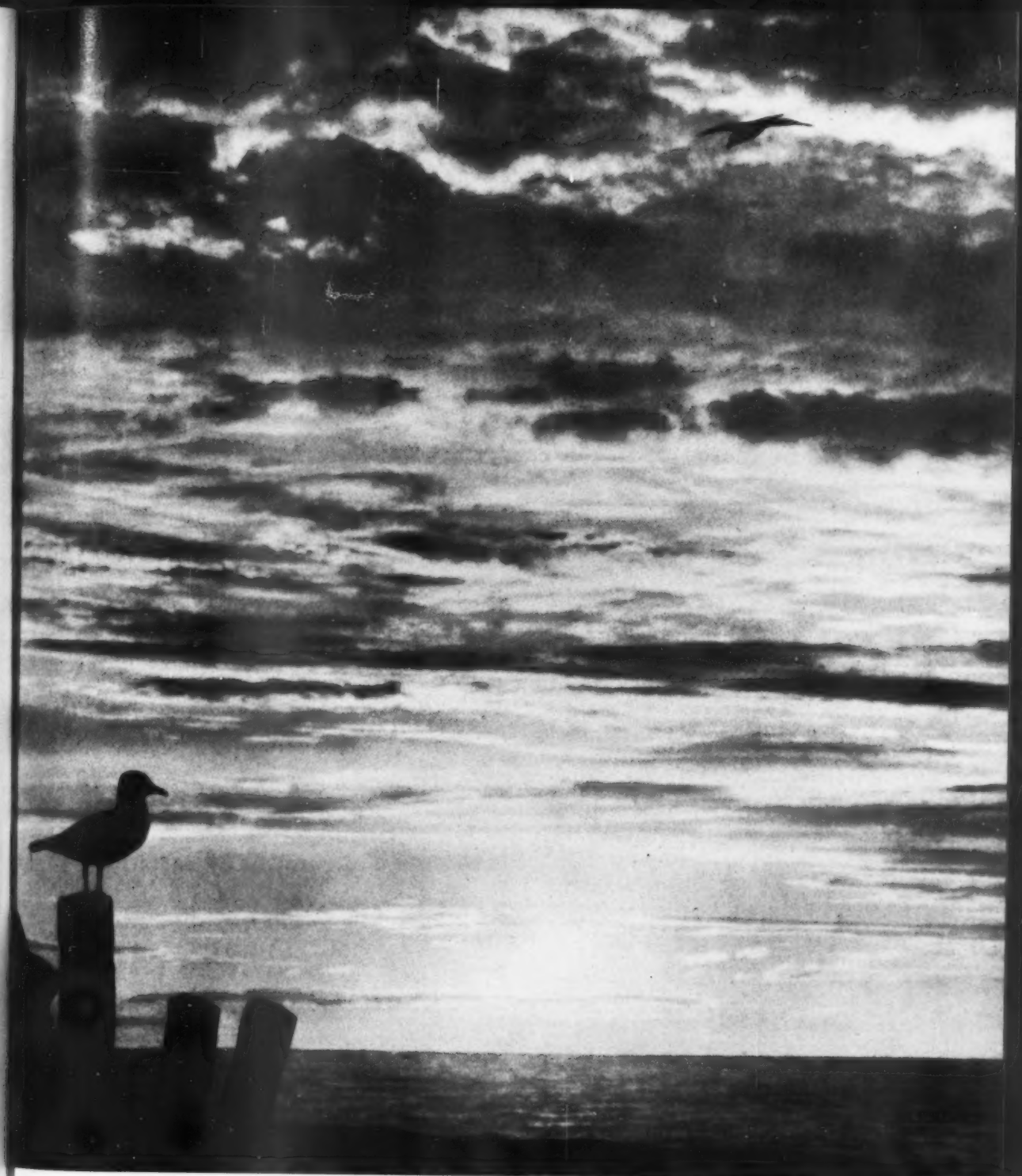

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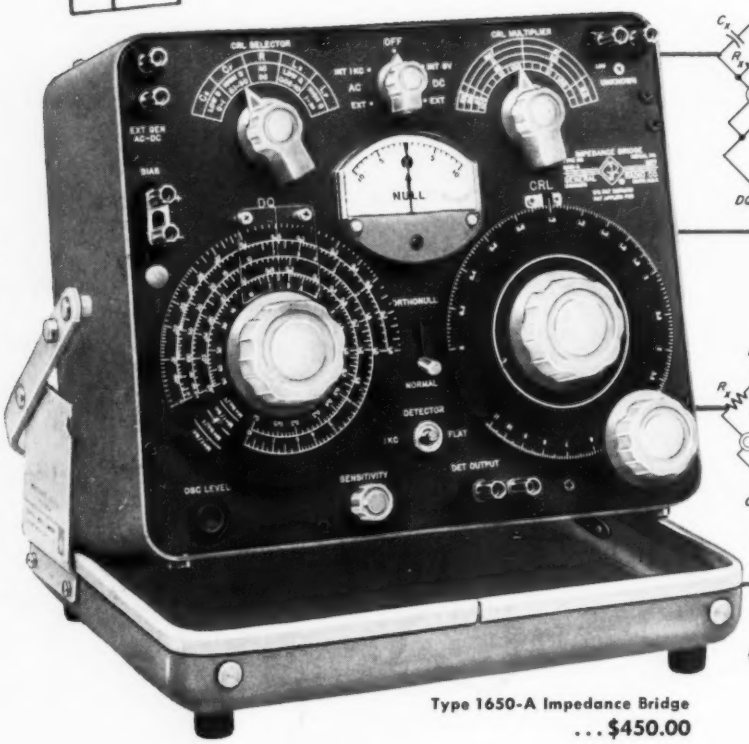

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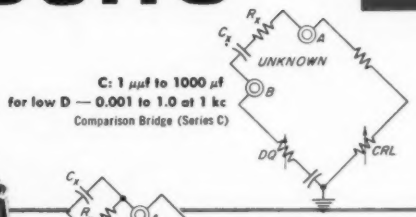

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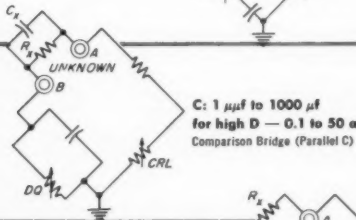

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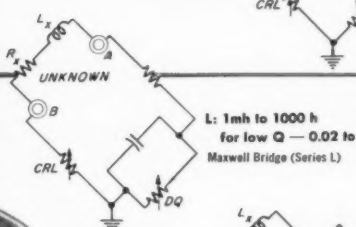

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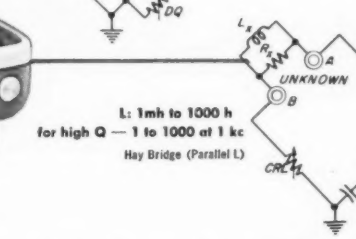

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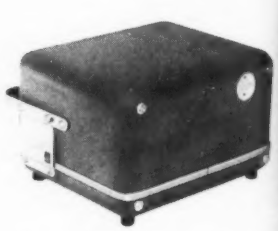

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